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THE TRAVELS OF A BOTANIST IN SOUTH-WEST AFRICA.*

(Percy Sladen Memorial Expedition, 1908–9. Report No. 1.)†

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The primary object of this expedition was to obtain material of *Gnetum africanum*, one of the three members of the phylum Gnetales known to occur in South-West Africa. In so far as was compatible with this quest, it was proposed to examine the flora of the dry regions of South-West Africa, mainly with reference to the relationships of the vegetation of the desert fringing the coast of Namaqualand, Damaraland and South Angola with that of contiguous areas. A visit to the montane forest region of Angola lying behind the port of St. Paul de Loanda was especially concerned with the search for Gnetum, and few observations of a phytogeographical nature were made; all reference to this part of the work of the expedition is therefore omitted from the following account, which deals mainly with the regions lying south of the latitude of Mossamedes.

Parts of this region have been visited by many botanical travellers within the last century. Prominent among these are Welwitsch, whose work in South Angola is memorable in the annals of botanical exploration; Schinz, whose long and arduous journey in Great Namaqualand, Damaraland, Ngamiland and Ovamboland has greatly enriched our knowledge of the vegetation of these countries; and Paterson, who crossed Little Bushmanland more than a century ago. But the region, even as limited in a preceding sentence, is so vast, and much of it so difficult of access—indeed, there are large areas into which the white

* Royal Geographical Society, January 10, 1910. Map, p. 620.

† Assisted by a grant from the Government Grant Committee of the Royal Society.

man has never penetrated—that our knowledge of the flora as a whole is still too slight to allow a general account of its phytogeography to be given. The first section of this paper, in which an outline of the more striking and obvious facts of geographical distribution is attempted, is designed to make the account of the journey which follows it more intelligible; it will be considerably modified and, in many particulars no doubt, corrected as our knowledge of the vegetation of South-West Africa is enlarged.

A. Outlines of the Phytogeography of South-West Africa.

The watershed separating the western drainage from that which flows eastwards,—either into the Indian ocean or to the lakes, marshes and salt-pans of the central plateau, or, in Namaqualand and Bushmanland, into the lower and middle course of the Orange river—is nowhere more than 200 miles from the west coast. It is broken through by the Orange river, rising mainly in Basutoland and the south-eastern Transvaal, and by the Kunene, whose waters are derived from the Benguella tableland and the eastern slopes of the Shellas. The general features of the country on opposite sides of the divide are, as is well known, very different. On the east there is a series of plateaux (2000 feet and upwards, in elevation) more or less diversified by abrupt hills, while, on the west, the descent is steep and greatly broken until it merges, near the sea, into a low-lying undulating plain which, in many parts, is covered by deep sand and massive sand-dunes.

Eastern Side of the Watershed.—The eastern plateaux vary a good deal in elevation, form of surface, nature of the soil and amount of water-supply, and in the composition of their respective floras. The Karoo, the most southerly of them, like its neighbour to the north, the "Composite"* region, is well known as regards the general characters of its vegetation, though much detailed work yet remains to be done upon both. It is an elliptic basin-like area with an average elevation of about 2500 feet, bounded on the west by the Lange Berg chain and separated from the "Composite" region by a great range known in different parts of its length as the Sneeuwberg, the Nieuwveld and its north-western continuation, the Roggeveld. At its western end the Karoo is continued as a narrow tongue to the north, following the trend of the Roggeveld range, under which it reaches the latitude of 31° 45′ S. (Draai Kraal). Its flora is dominated by fleshy-leaved plants belonging to various families; trees are absent except along the river-beds, where *Acacia horrida* (only occasionally attaining the stature of a tree) and *Rhus viminalis* are fairly common. The extensive range which separates the Karoo from the more elevated plateau to the north ("Composite"

* H. Bolus, 'Sketch of the Floral Regions of South Africa.' Science in South Africa. Cape Town: 1905.

region) connects the Drakensberg and the mountains of the Eastern Transvaal with Namaqualand; it forms an important highway across the sub-continent along which an interchange of Eastern and Western species occurs.

The flora of the "Composite" region is characterized, as its name implies, by the great preponderance of members of the family Compositæ. A considerable number of Karoo succulents, together with a few grasses, are also present. As in the Karoo, trees are absent except in the river-beds. The northern boundary of this region is somewhat indefinite; in its western part, at an elevation of about 3000 feet, it merges gradually into the sandy plains of Little Bushmanland, which fall gently to the north to the level of the Orange river, beyond which lies the Great Kalahari. In general, the flora of the Western Kalahari is that of Bushmanland at corresponding elevations. When the elevation is sufficient, as on hills of 5500–6000 feet in the latitude of Keetmanshoop, species characteristic of the Nieuwveld range and the "Composite" region reappear. The sandy surface of the undulating plains of Bushmanland is interrupted, at shorter or longer intervals, by large extruded blocks of gneiss with sand-polished surfaces, or by hills strewn with angular blocks. Owing to the irregularity of the rainfall, this country is without settled inhabitants, except in the neighbourhood of the Orange river, but districts which are favoured by rain are usually resorted to by farmers with their flocks and herds, from more arid regions to the south and west. In ordinary seasons travel in Bushmanland is attended by great difficulty, owing to the scarcity of surface-water and of food for the transport animals.

Dr. Rogers states that the geology of this great tract of country is known only in its barest outlines. A great part of the surface is occupied by acid igneous rocks which extend across Little Namaqualand and Bushmanland. The sand of Bushmanland "is derived from the minerals composing the gneissose granite that occupies such wide areas there. Quartz and felspar are the chief constituents, and, by the breaking up of the granite under the influence of the great diurnal change of temperature . . . the minerals are set free to be carried about by wind and rain. The sand is pink, owing to the abundance of red felspar, and also of the iron oxide derived from the ferrugineous constituents of the igneous rocks biotite, hornblende, hypersthene and magnetite." * The sand is very deep, and, in some places,—as between Aggennys and Pella, and on the Wolftoon above Henkriesfontein—is thrown into high dunes. Of the natural history of this region comparatively little is known. On the plains there is a considerable development of grasses—mainly species of Aristida—with which is usually found, sometimes in abundance, a leguminous bush or small tree, *Parkinsonia africana*. Scattered

* A. W. Rogers, 'The Geology of Cape Colony.' 1905.

bushes of *Rhigozum trichotomum*, *Senecio longiflorus*, and two or three species of Euphorbia resembling the latter in habit, occur with some frequency, especially round the bases of the hills. The curious Asclepiad, *Hoodia Gordoni*, with thick water-storing stems and large saucer-like flowers, is a characteristic plant over wide areas. Trees are few, and are practically confined to the vicinity of the water-holes, *Acacia Giraffæ*, *Euclea Pseudebenus*, a species of Ficus and a Rhus (*Rozynbosch*) being the most conspicuous. On the hills the flora is, in the main, that of the western mountains of Namaqualand. North of the Orange river, the genus Acacia plays a part in the composition of the flora, which gradually becomes more important. In the latitude of Windhoek (which lies a few miles to the west of the watershed) this genus predominates among the bushes, and, to a smaller extent, also among the trees, and this holds probably for the whole of the southern part of the plateau of Damaraland and Ovamboland.*. With the Acacias occur various other species of tropical affinity including *Combretum primigenium*, *Ficus dammarensis*,† etc. The same Acacia flora extends to the east towards Lake Ngami, with the omission of certain species (e.g. *A. albida* †), and with the inclusion of northern forms which are stated not to occur further west; such are palms (Hyphæne), *Adansonia digitata* (Baobab), and Sterculias.

A little south of lat. 20°, in Ovamboland, is the southern limit of a leguminous tree, *Copaifera Mopane*, which becomes a very important constituent of the open forest on the lower slopes of the Shella range in South Angola. These forests (north of the Kunene) also include several Acacias, among which the southern species, *A. albida* (the "ana" tree), occurs somewhat rarely. In more open spaces are found Baobabs, palms (two species of Hyphæne), Sterculias, figs and other trees. An epiphytic orchid (*Ansellia sp.*) is fairly common, and woody climbers of the families Menispermaceæ and Asclepiadaceæ occur not infrequently. The undergrowth includes several small Acanthaceous bushes and, in the summer rainy season, a large number of grasses. A forest of the same type clothes the lower slopes of the Shella range on its western face.

Western Side of the Watershed.—The strip of country lying on the west side of the watershed and extending northwards from the mouth of the Oliphants river, varies considerably in breadth, its narrowest part being probably through the so-called "Kaokoveld" which constitutes the seaboard in the northern part of German territory. The flora of the low-lying littoral desert belt differs in many respects from that of the more mountainous zone which separates it from the watershed. In the south, the montane flora includes that remarkable tree

* Galton, 'Narrative of an Explorer, etc.' Minerva Library: 1889.
† Schinz, 'Süd-West Africa.' Leipzig: 1894.

Aloe dichotoma, which ranges from Brak Rivier (lat. 31° 15′ S.) in little Namaqualand, into the tropics. At Haigamkhab (lat. 22° S.) and farther north in the Khan river-basin,* it is less abundant than in the south, and this, together with its comparatively meagre habit, suggests that it is here not far from its northern limit. With it there occur *Vogelia africana*, *Exomis albicans*, *Vahlia capensis*, low-growing species of Bauhinia, various Acanthaceous and Amarantaceous bushes and other peculiar forms. In Angola, Damaraland and Northern Namaqualand, the transition from the montane zone to the littoral desert is perhaps indicated by the presence of certain species of Vitis (Vines), which, on account of their tuberous stems, fleshy leaves and non-climbing habit, have been placed by Engler in a distinct section of the genus. Among these species are *V. macropus*,† *V. Bainesii*, and *V. Cramerianus*,† the first in South Angola, the two latter in Damaraland and Northern Namaqualand, at elevations between 1000 and 2500 feet. Further south they appear to be replaced by various species of Euphorbia—"Euphorbia-steppe" of Schinz ‡—occurring between 2500 and 3000 feet in Namaqualand. In Damaraland and the northern part of Great Namaqualand, the Acacia park-forest of the plateau descends for some distance on the western side of the watershed.

The desert littoral is a low-lying plateau, frequently sand-covered near the sea. Over large areas in the southern part of Great Namaqualand, the sand has been removed by the wind, leaving behind a stony surface, from which, in the districts south of Lüderitzbucht, diamonds are now being obtained. Elsewhere the sand has been heaped up in large dunes such as those which occupy nearly the whole of the British territory of Walfish bay. In Little Namaqualand these littoral sands bear a fairly rich flora, in which many species of Mesembrianthemum, Compositæ, Amarantaceæ, Asclepiadaceæ, Euphorbiaceæ and bulbous plants are conspicuous, and from which trees are absent. Near the mouth of the Orange river the vegetation becomes very sparse and the sand-dunes along the banks are said to be exceedingly barren. Just north of the river a few Bushmen and Hottentots live on its produce and on the fruits of that remarkable Cucurbitaceous plant, *Acanthosicyos horrida*, which is endemic in the South-Western African littoral. But it is generally believed that this species does not occur naturally so far south, but has been introduced here by the natives.‡ Its true southern limit is said to be not far from the southern extremity of Walfish bay; it is reported to occur almost as far north as Mossamedes in South Angola. Perhaps the most characteristic species is *Welwitschia mirabilis* which ranges between lat. 27° and 14° S. With these occur also, at wide

* Pearson in Kew Bulletin, 1907.
† *Botanical Magazine*, T. 5479.
‡ Schinz, *l.c.*

intervals, *Statice scabra*, Euphorbias, a few Composites, Leguminosæ, Ficoideæ, species of Tribulus, etc.

Where the mountain-tops rise above the general level of the watershed and exceed 5000 feet, there occur isolated developments of floras which are naturally centred in more southern localities. The presence of a "Composite" region flora between 5500 and 6000 feet at Schakalskuppe in Great Namaqualand has already been mentioned. On the Huilla plateau (6000–6500 feet) in South Angola, on the Kamies Berg * (6000 feet) in Little Namaqualand, and perhaps also on other ranges of high elevation (*e.g.* Omatako, 8700 feet, in Damaraland, Auas Berg south of Windhoek and the Karas Berg in Namaqualand) the vegetation is distinguished by the presence of Proteaceæ and of other forms which, with them, constitute the dominant features of the flora of the Cape region; the latter effects a junction with the coast region of Namaqualand in the neighbourhood of the mouth of the Oliphant's river.†

B.—An Account of the Journey.

The route of the expedition from Cape Town to the coast of Great Namaqualand crossed, in turn, the Cape region, the northern arm of the Karoo, the "Composite" region, the Namaqualand Montane region, Little Bushmanland, the Orange river belt, the south-western fringe of the Great Kalahari, the main watershed (between Shakals Kuppe and Aus) and the littoral desert, reaching the sea at Lüderitzbucht. Thus far I travelled in company with my colleague, Dr. J. C. Beattie, to whom, and to the courtesy of the Director of the Department of Magnetism of the Carnegie Institute of Washington, I am indebted for permission to use Dr. Beattie's determinations of latitude and longitude made in connection with the magnetic survey, in the preparation of the map which accompanies this paper.

In Damaraland and in South Angola, the desert strip was crossed in the opposite direction; in the latter region the journey was continued up the western slope of the Shella range, across the Huilla plateau and down to Fort Rosadas on the eastern bank of the Kunene river.

Ceres to Karoo Poort. Nov. 27 *to Nov.* 30, 1908. *Cape Region.*—The waggon journey commenced at Ceres Road railway station situated at the foot of the Lange Berg range in the valley of the Breede river. After ascending Mitchell's pass through this range to the Ceres plateau (1100 feet) the Calvinia road winds over an undulating plateau rising here and there to 3000 feet. The country suffers from frequent droughts, one of which occurred in 1908, and is sparsely populated. It is mainly a grazing district supporting a considerable number

* Marloth, 'Report of the British Association,' 1905.

† Bolus, *l.c.*

of ostriches, sheep and goats. Horse-breeding is carried on to some extent. Wheat and oats are cultivated on a limited scale—the latter principally for fodder. The indigenous flora is of the same type as that which flourishes in the more mountainous districts of the Cape region but appears to be much poorer in species. Proteaceæ and other typical forms are more especially characteristic of the higher ground. Along the roadsides and elsewhere where the natural vegetation has been trampled or burnt out, a dense scrub of the Rhenoster Bush (*Elytropappus Rhinoceroti*) has taken possession of the land and has rendered it of little value for grazing or for agricultural purposes. Succulents become more abundant as the Karoo is approached; there are clear indications that the practice of burning the veldt, which appears to be widespread, leads to the disappearance of many natural species and their partial replacement by more resistant forms or by Karoo succulents, of a lower economic value. From Hottentots' Kloof the track follows a valley which ends in a gap in the hills (Karoo Poort *) beyond which it emerges abruptly upon the Karoo at about 2000 feet.

Karoo Poort to Draai Kraal, Nov. 30 to Dec. 6. Karoo.—From Karoo Poort to Draai Kraal, the road traverses a depression which, at Stompies Fontein, falls as low as 800 feet. Always dry, this arm of the Karoo was at this time a monotonous arid waste, over many parts of which the drought had been unbroken for so long as four years. The waters—surface-drainage collected in natural hollows or shallow pits, or derived from weak springs and in this case disagreeably impregnated with sulphuretted hydrogen—were 20 miles or more apart; they were generally impure and frequently fetid. Near the water-holes, the soil is usually rich in soluble salts, and halophytic vegetation is common. Prominent among this is frequently an extensive development of *Suæda fruticosa* from which the few white inhabitants obtain a substitute for ink. Away from these localities the flora is of a different character. On rocky ground near Karoo Poort there flourish many species characteristic of the western part of the Karoo near Matjesfontein. Among these may be mentioned a remarkable Crassulaceous tree, *Cotyledon fascicularis*,† and other representatives of the same family, a Euphorbia, in habit resembling *E. mauritanica*, and various Mesembrianthema, including *M. crystallinum*. Lichens are common. *Acacia horrida* and *Rhus viminalis*, *Galenia fruticosa* and the grass *Ehrharta spinosa* occur in sandy patches along the dry river-beds. Further north the effects of the severe drought became more obvious. Large stony patches were quite destitute of vegetation, or bore a

* This pass lies north and west of that described by Burchell under the same name. Burchell, W. J., 'Travels in the Interior of Southern Africa,' vol. 1, p. 207. London: 1822.

† Yapp in *New Phytologist*, vol. 5, 1906, Pl. 6, Fig. 1.

scattered array of Mesembrianthema or the curious Zygophyllaceous succulent, *Augea capensis*. Dead plants of *Euphorbia spp.*, *Codon africanum*, *Sarcocaulon sp.*, a succulent supposed to be *Hoodia africana*, *Galenia fruticosa* and some composites, were common. Many of the barren areas were undoubtedly saline, but in other cases no signs of salinity could be detected, and then it seemed that *Augea capensis* and species of Mesembrianthemum were the last to yield to the excessive drought; when these succumbed the ground was left untenanted. This extremely barren stretch of country is very sparsely populated, and, of the few farms seen, perhaps the majority were temporarily abandoned by their occupiers who, with their livestock, had "trekked" into Bushmanland and elsewhere in search of food and water. The stock consists almost entirely of sheep and goats with a few ostriches. The country is quite unsuited to oxen and our own team suffered severely from want of fresh food during the six days occupied in crossing it. The donkey is the most successful draught animal. Of cultivation there is, of course, very little and this is practically confined to the river-beds. Here are grown under irrigation, wheat, rye, mealies (*Zea Mays*), potatoes, pumpkins, figs and dates. In addition to the more serious difficulties of travelling due directly or indirectly to want of water, dust and flies are an almost intolerable nuisance.

Draaikraal to Loeries Fontein, Dec. 6 to Dec. 12. Karoo, "Composite" and Namaqualand Montane Regions.—A sudden rise of about 1000 feet through a pass (locally known as the Blaukrantz) leads from Draai Kraal through a spur of the Roggeveld range to the plateau on which Calvinia is situated. The flora becomes much richer, especially in Composites, while succulents decline in importance; on rocky ground towards the top of the pass, lichens, crustaceous and foliose, are very abundant. The species are in many cases the same as those found on the Nieuwveld range near Beaufort West. For a considerable distance north of Calvinia, at elevations of 2500 feet and upwards, the flora is that of the "Composite" region. Below this, in mountainous districts, the vegetation is mainly that of the Namaqualand Montane region; but where the surface is less broken Karoid species or Bushmanland grasses predominate. The existence of one or other of these floras seems to depend primarily upon elevation; certain other factors, especially perhaps the nature of the soil, are also important.

Away from the high ridge of the Roggeveld, towards Calvinia, the effects of severe drought were again marked, and the vegetation was poor. One of the most remarkable plants found in abundance north of Calvinia was a minute Helichrysum ("Everlasting"), gregarious over large areas, whose white indumentum glistened in the sunlight like the distant gleam of snow. In the vicinity of Calvinia, Mr. Van Dijk has carried on, for some years, very successful experiments in the cultivation of lucerne; he now has about 60 acres under irrigation along the

BUSHMANLAND. A VIEW FROM A HILL NORTH OF KWEEKFONTEIN, LOOKING SOUTH-WEST. *ALOE DICHOTOMA* (LEFT CENTRE) AND *COTYLEDON FASCICULARIS* (RIGHT) IN FOREGROUND. THE ALOE IS 15 TO 20 FEET HIGH.

BUSHMANLAND. DABAINORIS. *EUCLEA PSEUDEBENUS* AND *TAMARIX ARTICULATA* NEAR THE WATER-HOLE IN THE MIDDLE DISTANCE. PACHYPODIUM OCCURS ON THE LOW SCHISTOSE HILL ON THE LEFT.

BUSHMANLAND. *PACHYPODIUM NAMAQUANUM* AT DABAINORIS. A COMMIPHORA IS SEEN ON THE RIGHT BEHIND THE PACHYPODIUM. THE NATIVE IS A BONDELZWART.

ORANGE RIVER AT RAMAN'S DRIFT, LOOKING NORTH. THE BRITISH STATION IS SEEN IN THE FOREGROUND; THE GERMAN ON THE OTHER SIDE OF THE RIVER. THE TRACK TO WARMBAD FOLLOWS THE SANDY VALLEY SEEN IN THE MIDDLE DISTANCE. THE TREES ON THE RIVER-BANK ARE *ACACIA HORRIDA* AND *SALIX-CAPENSIS*.

Oorlog river. By careful treatment, as many as six good crops are obtained from a single sowing. It is used as fresh food and fodder for ostriches, horses, mules and small stock. It is probable that this crop will prove to be of great importance in this district, which suffers so severely from the failure of rainfall. Other crops include salt bushes and various vegetables and fruits. Among the latter are peaches, pears, oranges, lemons, grapes and water-melons. Another introduced plant, more or less under cultivation, is a Mediterranean Tamarix which furnishes fuel and small wood. Common weeds include *Asclepias fruticosa* and an Opuntia (prickly pear).

North of Holle Rivier the road to Loeries Fontein frequently passes over tracts below 2500 feet; here are encountered southern extensions of the Namaqualand Montane flora. The first example was seen in crossing the bed of the Klein Doorn Rivier, about 20 miles north-west by west from Calvinia; a still more marked case was found 6 miles further on at Brak Rivier (1600 feet), where, in addition to many species of Karoo and "Composite" region affinity, there occurred *Tamarix articulata*, *Aloe dichotoma*, *Statice scabra*, *Vogelia africana*, *Exomis albicans*, several species of Zygophyllum and a Ficus. Most of these and other equally characteristic species are common throughout the Montane or littoral regions of Namaqualand and extend northwards beyond the tropic into Damaraland.

Cattle were met with to the north of Brak Rivier, but south of Loeries Fontein the stock consists mainly of sheep, goats and ostriches; mules and donkeys are the common draught-animals. The small Dutch hamlet of Loeries Fontein is situated on a branch of the Kromme Rivier, periodically a stream, uniting lower down with the Doorn which reaches the sea by way of the Oliphant's river. It is an agricultural settlement with 100 or 150 white inhabitants, and is surrounded by extensive fields of wheat and oats. The drought here had been far less severe than farther south. In the immediate neighbourhood of the hamlet, the deep-cut ravines are bounded by steep cliffs of a black, crumbling, shaly rock in thin horizontal layers. These support a poor flora; here and there a trickle of water exudes and maintains a fairly luxuriant growth of Adiantum and other mesophytic plants and even a few reeds.

Loeries Fontein to O'okiep. Dec. 13 *to Dec.* 27. *Namaqualand Montane region and Bushmanland.*—From Loeriesfontein the road to Nieuwe Fontein descends at first in the bed of the Kromme river and afterwards across a series of sandy plains towards a southern spur of the Lange Berg* range. After crossing this, it emerges upon an extensive plain with a uniformly sandy surface, lying to the south-west of the main extent

* This range is quite distinct from the more important one of the same name previously mentioned (see p. 486).

of the range. This plain slopes gently down to a huge granite rock with a flat top, beneath which is a small supply of water at the bottom of a shallow excavation (1600 feet). This rock gives the name Plaat Klip to the locality, in which, at the time of our visit, the only inhabitants were a family of "Trek-Boers." The flora of the Lange Berg is very rich, its most conspicuous elements being *Aloe dichotoma* and many other forms characteristic of the Namaqualand Montane region; the genus Commiphora was represented by a species apparently closely related to *C. saxicola* of the Welwitschia desert in Damaraland. *Hoodia Gordoni* was very numerously represented on the sandy plains on both sides of the mountain range. Many other succulents and several halophytic species were present, but a severe drought had prevailed for some time and the vegetation was in poor condition.

Between 15 and 20 miles beyond Plaat Klip, while the vegetation still maintained many Namaqualand features, a marked change, due to an increase in the proportion of grasses (chiefly species of Aristida), occurred. This indicated the commencement of the Bushmanland flora. Secretary birds were here seen for the first time. For some distance beyond this point the road became heavy and the waggon wheels sank deep into the sand. The guide missed the way, and for three days the oxen were without water and suffered severely. During the night of Dec. 17, the fore part of the lightly laden waggon had to be unloaded before it could be extricated from the deep sand of a dry river-bed in which it had stuck fast.

From Plaat Klip to within a few miles of Nieuwe Fontein the plains were dried up and much of the vegetation was represented only by dead specimens. A few small geophytes were in flower, and one minute annual—a Helichrysum—was collected. On the hills, the species which had withstood the drought were all of Namaqualand affinity. Nieuwe Fontein (2700 feet), a small Dutch settlement of about half a dozen houses, has a small supply of fairly good water, but its very unsanitary conditions make it an extremely unpleasant place to stay in. As at the majority of the water-holes of Namaqualand and Bushmanland, the water-supply is uncared for and the ground surrounding it for a mile or two on every side is trampled bare of vegetation by the stock resorting to it. The latter includes cattle, sheep, horses, donkeys, geese and hens. These travel far in the surrounding country in search of food. In the immediate neighbourhood of the settlement the country was extremely bare, and the presence of many dead perennials showed that this was due, at least in part, to the severity of the drought and not entirely to goats. The flora appears to be of a somewhat complex character; it includes many Composites and other forms whose affinities are with the "Composite" region, Bushmanland grasses and, in rocky places, *Vogelia africana* and other species of Namaqualand relationships. An Agave is used in the settlement as a hedge plant; in the very

unpretentious gardens were seen Pepper trees (*Schinus molle*), *Nicotiana glauca*, a Hollyhock and a low-growing species of Erythrina.

Rain in these regions occurs in the summer and is usually an accompaniment of thunderstorms, and therefore presumably very local in its distribution. This, no doubt, accounts for the very limited areas of the fertile patches in which the vegetation is in good condition. It was a common experience, after travelling for hours over a dry stretch in which the perennial species were mostly dead and from which annuals were absent, to enter suddenly a region in which the vegetation was in full activity and the surface sprinkled with flowers. A little to the north of Alewyn's Fontein (2900 feet) the ground was almost as barren as the Namib; no living grasses were seen, and even of so resistant a species as *Mesembrianthemum crystallinum*, very few plants were left alive. A few weeks earlier, it was stated, the whole of this district had been green with young grasses. The contact of the Namaqualand, Karoo, Nieuwveld, and Bushmanland floras was well shown on December 23 about 20 miles north of Alewyn's Fontein. On a wide plain at about 3200 feet, a shrubby grass (*Aristida namaquensis?*), a common species on sandy ground throughout western Bushmanland, was the predominant plant. A mile to the west of the outspan there was a sudden fall of about 500 feet, through very broken country, into the bed of the periodical river Kansaap. On the rugged slopes, occurred a flora which included species found also on the Nieuwveld mountains, some succulents, especially Cotyledons and Mesembrianthema, together with *Aloe dichotoma* and other Namaqualand forms. A similar admixture was found in the remarkably broken country surrounding the waterhole of Kamabies (3000 feet), where no rain had fallen for five months, and where consequently but few annuals and other delicate forms were obtained. Here, as in many other localities, the fact that dry mountainous country is commonly rich in species and poor in individuals, while on flat ground the converse is usually found, was well illustrated.

The full development of the characteristic flora of Little Bushmanland was first encountered a few miles south of Rietfontein (2300 feet). Three very typical species were present, two in great abundance, viz. the shrubby Aristida already mentioned and a bushy species of Mesembrianthemum (allied to *M. spinosum*), while the leguminous bush *Parkinsonia africana*, afterwards so common, was represented by a few struggling specimens, this locality being probably very near its southern limit. On the hills, the Namaqualand montane species still prevailed; around their bases was a fairly dense growth of a smooth, thick-stemmed Euphorbia, believed to be an undescribed species, which has been experimentally used by a Namaqualand firm for the extraction of rubber. A curious habit of growth was observed in many of the perennial sand-loving species here and afterwards more abundantly throughout Bushmanland and Great Namaqualand. Conspicuous among

these were *Zygophyllum lichtensteinianum*, *Aristida sp.* and *Asparagus sp.* The plant, once established, throws out rhizomes in all directions, and eventually all the living shoots are arranged in a circle round a sandy centre beneath which lie the older dead parts of the plant. The general arrangement reminds one of the fairy rings of the mushroom; in this case it may be due partly or entirely to the exhaustion of certain mineral constituents of the soil in the "atolls." The dead vegetation in the centre, lightly covered by sand, must undoubtedly play an important part in conserving the moisture deposited as dew.* Rietfontein, as its name implies, is a reed-girt series of springs, in the broad sandy bed of the Riet river, a tributary of the Doorn river. Under the energetic and skilful management of a firm whose principal members are respectively of Huguenot and Scotch † descent, cultivation under irrigation in this river-bed has been attended with conspicuous success. Here are produced crops of wheat, lucerne, figs, dates, plums, peaches, apricots, grapes and pomegranates. The hedges are of quince. The loquat (*Eriobotrya japonica*) is in cultivation, but is not promising well at present. Amarantaceæ play an important part in the composition of the flora to the north of Rietfontein.

At Rietfontein our transport broke down completely. Twelve of the team of twenty oxen were dead or abandoned, and those that remained were in a weakened and emaciated condition. It was therefore necessary to proceed in a hired cart to O'okiep, and there to make fresh arrangements for the next stage of the journey, while our own waggon came in at a slower pace. We crossed a watershed from south-east to north-west (Baviaan's Kloof) soon after leaving Rietfontein, and followed a road through a mountainous country in which the slopes bore the Namaqualand Montane flora, while the narrow valleys were mostly under cultivation. Springbok, the capital of Namaqualand and the headquarters for the district of the magistrate and the Cape Mounted Police, is a village whose interests are mainly in agriculture and stock-farming; there is also a small copper-mine worked by the Cape Copper Company. The railway projected to connect it with O'okiep, about 6 miles to the north, is not yet built. O'okiep (3050 feet) is the headquarters of the Cape Copper Company. Its white inhabitants, who are almost entirely English or of British descent, are chiefly engaged directly or indirectly in the extraction of copper from the surrounding hills; it is also the centre of an extensive native trade throughout Namaqualand and Bushmanland. The settlement is situated about 8 miles west of the watershed, beyond which lies Bushmanland; it is connected with the coast at Port Nolloth by a light

* *Cf.* 'Tunic Grasses,' Hackel, *Verh. Zool.-Bot. Ges. Wien*, 1890.

† Mr. Kennedy, an old man, who, with his family, is quite ignorant of English. His father emigrated from Aberdeen and was probably the Kennedy mentioned by Sir James Alexander, *l.c.*, pp. 69 and 85.

railway through Steinkop, the northern terminus of the Cape Telegraph system. This railway, the property of the Cape Copper Company, was largely used as far as Steinkop for the transport of supplies to the Germans during the recent war with the Bondelzwarts. From Steinkop the goods were carried, mainly by ox-waggon, over the Orange river at Raman's drift to Warmbad. The copper ore is carried by rail from O'okiep to Port Nolloth and thence shipped, chiefly in sailing-vessels, to South Wales.

O'okiep to Pella, Jan. 3 to Jan. 8, 1909. Namaqualand Montane Region and Bushmanland.—For a somewhat rapid journey through Little Bushmanland, a light waggon drawn by a team of ten mules was employed. These animals travel faster than oxen, and are of great service in dry districts. But, if they are to be kept in good condition, the waggon must be partly laden with corn for their use, and this is consequently a more expensive form of transport than the ox-waggon. The summer of 1908–09 brought rain to many parts of western Bushmanland, and although its distribution showed curious limitations as in districts farther south, the vegetation on the whole was fairly vigorous. The scenery, picturesque but monotonous, is characterized by extensive stretches of sand, bearing a flora poor in species as well as in individuals, and interrupted at short or longer intervals by sharply outlined hills whose height rarely exceeds 1000 feet, and at the bases of which there is usually a great development of Euphorbias. The water-holes are usually situated at the foot of a hill, at or near the lowest point of a wide sloping plain. They are shallow excavations, from which a copious supply is, however, frequently obtained. Such water-holes are sometimes many miles distant from one another; certain roads can only be used after a rainfall sufficient to fill natural or artificial depressions with surface drainage. There can be no doubt that water for irrigation purposes could be obtained in many parts of Bushmanland by judicious boring operations. Except during one of the frequent sandstorms, the air is remarkably clear, and even during the summer when the mid-day heat is intense, the climate is very healthy and invigorating.

The general features of the flora have already been described (see p. 483). *Parkinsonia africana* is a common constituent of the Aristida steppe. Frequently the grasses are dominated or almost replaced by a bush steppe composed mainly of the Bignoniaceous *Rhigozum trichotomum*, in company with a large-flowered Hermannia which attains a height of 2 to 3 feet. *Hoodia Gordoni* is a characteristic plant over large areas; its fleshy stems are eaten by the natives when other water-supplies are not available. Trees are rarely met with; they occur only in depressions so situated as to receive the underground drainage of a large area. *Acacia Giraffæ* (the camel-thorn) was first observed at Aggennys and was quite common at Pella. Aggennys is remarkable

for the great development of a Euphorbia steppe consisting almost exclusively of a single species at present undetermined. The same species occurs again in great abundance on sandstone near Zandverhaar, in Great Namaqualand. The mountains around Aggennys bear a rich flora of Namaqualand affinity; a Ficus forms a tree 25 feet high. A Commiphora—probably the species already referred to (p. 490)—is common on the rough hills at Ougrabies.

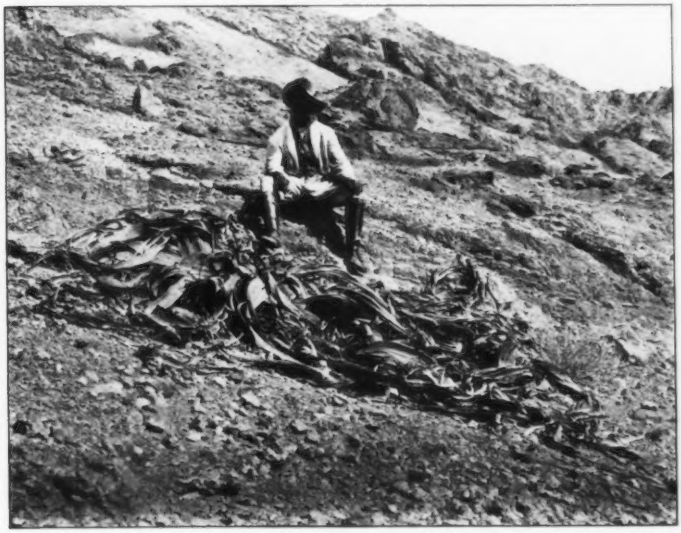
Pella (1600 feet), some 6 miles south of the Orange river, is at the lowest point of an extensive sandy plain, where it is bounded by an abrupt range of hills behind which lies the Orange river. It is the seat of a Roman Catholic mission, around which a Hottentot settlement has grown up. It has a copious water-supply from a boring 20 feet deep. The extensive gardens are well stocked with good fruit trees, which, however, are not successful after a few years, when their roots have reached calcareous strata, said to occur only a few feet beneath the surface. The mission has recently started the cultivation of cereals and fruit trees on the south bank of the Orange river. The water for irrigation is obtained from the river by steam-pumps burning wood fuel.

Pella to Steinkop, Jan. 8 *to Jan.* 16. *Bushmanland, Orange River, Namaqualand Montane Region.*—Around the water-hole at Dabenoris (1500 feet) were several trees of the black ebony (*Euclea Pseudebenus*), the camel-thorn and a thick scrub of *Tamarix articulata*. On the top of the great mountain mass of Dabenatup, to the north-west of the water-hole, is a heliograph station, one of the links in the chain of communications between the police camp at Raman's drift and Springbok. On the lower hills at its foot, growing in community with *Aloe dichotoma*, *Commiphora sp.*, and a few other species, was found that very remarkable Apocynaceous succulent, *Pachypodium namaquanum*, discovered, perhaps on the same hills, by Lieut. Paterson in 1779.*

The bed of the Orange river between Pella and Raman's drift lies in a gorge enclosed between steep mountain slopes, rising 1000 to 1500 feet above it, which, viewed from a short distance, appear to be quite arid and bare of vegetation. A closer examination reveals the presence of a few trees of *Aloe dichotoma* and clumps of the thick ridged stems of *Euphorbia virosa*, a species occurring also in similar situations in the ravines of the lower Swakop, in Damaraland. A few specimens of a small bushy Asclepiad and some struggling shrubs of *Bauhinia garipensis* almost complete the flora found above the level of the sandy valleys. A zone a few yards wide, on either side of the river along the water's edge, is covered with a fairly dense bush which includes *Salix capensis*, *Acacia horrida*, *Zizyphus mucronata*, *Euclea Pseudebenus*, *Tamaria articulata* and a few shrubs, perennial grasses and sedges; otherwise the flora of the river-

* *See* Pearson in *Gardeners' Chronicle*, **46** (1900), p. 369, fig. 162.

ORANGE RIVER AT RAMAN'S DRIFT, LOOKING SOUTH. THE RIVER (ABOUT 600 YARDS WIDE) IS CONSIDERABLY ABOVE THE NORMAL LEVEL, AND IS NOW SUBSIDING. THE BRITISH STATION IS SEEN ON THE OTHER SIDE; POLICE CAMP ON THE RIGHT, CUSTOM HOUSE SHED IN THE MIDDLE, FERRYMAN'S HOUSE ON THE LEFT. THE PRECEDING PICTURE REPRESENTS THE VIEW FROM THE LOW HILL TO THE LEFT OF THE POLICE CAMP.



DAMARALAND. A LATERAL RAVINE OF THE KHAN RIVER A FEW MILES ABOVE ITS JUNCTION WITH THE SWAKOP. *WELWITSCHIA MIRABILIS.* THE NATIVE IS AN OVAMBO.

DAMARALAND. THE "NAMIB" NEAR WELWITSCH, ABOUT 3 MILES EAST OF THE KHAN RIVER. *WELWITSCHIA MIRABILIS.*

SOUTH ANGOLA. THE FRONT OF THE SHELLA RANGE AS SEEN FROM KAPANGOMBE, LOOKING EAST, SHOWING THE GAP IN WHICH LIES THE FOOTPATH TO HUMPATA ON THE HUILLA PLATEAU. TO THE RIGHT ARE SEEN AN ANGLE OF THE KAPANGOMBE FORT AND TWO TREES OF AN ACACIA, PROBABLY *A. ALBIDA*. THE LOW VEGETATION IN THE FOREGROUND CONSISTS VERY LARGELY OF GRASSES.

valley is that of a tropical desert. The vegetation between the river-side and the semi-desert plateau in which the river-gorges are cut is therefore of two types, each represented by belts running parallel with the course of the stream. The lower of these, a xerophytic woodland formation, owes its existence to subterranean water derived from the river by infiltration; above this the conspicuous elements of the flora are species characteristic of the Welwitschia desert in the north. The presence of a desert above the fringe of river-side bush seems to be due mainly to the peculiar situation of the river-bed. The sides of the deep gorge in which it lies become intensely heated every day and, at night, the temperature rarely falls below the point of saturation. Clouds and rain are therefore of rare occurrence, even when the neighbouring plateau is visited by thunderstorms. In the after part of the day violent winds commonly sweep up the gorge, carrying with them clouds of sand so dense that the other side of the river is obscured for hours at a stretch; all the loose and light particles are removed from the slopes, and, not only is the power of absorption of atmospheric moisture thus reduced to a minimum, but it becomes impossible for a plant to maintain a foothold except in a crevice of the solid rock. The conditions therefore demand a high degree of xerophytic adaptation, and both the mean and the maximum temperatures are higher than on the plateau in the same latitude.

At Raman's drift, a few feet above the high-water mark, there is a camp of the Cape Mounted Police, which is normally maintained at the strength of one N.C.O. and four troopers. These patrol the river from the drift to the mouth, and for a short distance in the opposite direction towards Pella. A custom-house officer and a ferryman complete the number of the white population. The German frontier station stands opposite. The approach to the drift from each side is overlooked for some distance by the summit of a prominent mountain mass on the opposite bank.

The road from the drift to Henkriesfontein passes all the way through heavy sand, up a broad river-bed and, at length, down the almost precipitous southern face of the Wolftoon. This remarkable formation consists of a number of bosses of gneiss at fairly regular intervals projecting from the top of a high ridge; the hollows between them are partially filled by sand blown up from the plain below. As seen from the south they bear an easily fancied resemblance to the toes of the hyena (wolf). Henkriesfontein is situated at the lower edge of the very extensive plain which supplies the Wolftoon sands, and possesses a fine natural water-supply, said to be the best in Bushmanland. This native reserve is occupied by a few Bastards owning small herds of cattle. There is a large extent of ground capable of irrigation, whose possibilities are even greater than those which have been realised at Pella. The native vegetation shows the characters which

seem to be constant throughout western Bushmanland, viz. a Kalahari flora on the plains, Orange river trees near the water-hole and Namaqualand species on the hills; the latter are much less barren than those bordering the river.

O'okiep to Warmbad. Jan. 18 *to Jan.* 27. *Namaqualand Montane region, Bushmanland, Orange river and Kalahari.*—The most direct transport route between O'okiep and Raman's drift lies between those already indicated—the one passing through Pella and the other through Henkriesfontein. It passes through the copper-mining centre Concordia, which is in communication with the Port Nolloth railway through a junction a short distance north of O'okiep. The road is badly provided with water, the last supply being passed at Aus, 25 miles from the drift. A few miles from the latter place, it runs under the remarkable granite dome known as the "Gesellschap bank" (presumably named from a copper mine situated in its vicinity). This great mass has a polished surface and is almost without vegetation except in a broad rift, filled with loose blocks and rubble, which extends from base to summit. A very similar formation is seen at Kweekfontein and elsewhere in Bushmanland. Gesellschap Bank stands near the upper edge of the broad sandy stretch at the north-western corner of which, some 10 miles away, lies Henkriesfontein. On January 22, the Wolftoon and the hills at the back of Henkriesfontein were hidden from view by a dense cloud of blown sand, which made it easy to account for the great waves of sand in which these ranges were previously found to be enveloped.

On January 24, the Orange river was several feet higher than it had been ten days earlier. It was now at a low flood level and was estimated to be 600 yards wide at Raman's drift. Much of the bush stood some feet deep in water. The current was very rapid and the use of the large "pontoon" (designed to carry a loaded waggon) was consequently impossible. At the same time, so many uprooted trees and dead animals were being hurried down to the sea that the crossing in small boats was attended by some risk. The frontier-line is the high-water mark on the north bank, and therefore the bush on both sides lies in British territory. It is of little economic value; poles of *Zizyphus mucronata* are used in Namaqualand—practically a treeless country—for hut-building. Where the bush has disappeared—apparently in consequence of its exploitation for firewood,—the water's edge is fringed by a luxuriant growth of *Nicotiana glauca*. The small seeds of this plant are deposited in the mud as the water-level sinks, and they quickly germinate. The plants grow rapidly until the water rises again, and it appears that, as soon as the dried mud in which they are growing becomes once more saturated, every plant is killed. The line which separates the living from the dead bushes of this species may therefore be taken as a rough indication of the highest water-level attained since the plants became

established. Various Cucurbitaceæ are under cultivation here and there on the river-banks; their fruits—in particular water-melons—are produced in great profusion and attain a remarkable size.

The German station at Raman's drift is in telephonic communication with Windhoek. Its white population is about equal to that on the opposite side. Several houses erected during the recent war, when much transport crossed the river at this point, are now empty and abandoned. As the new railway south from Seeheim approaches Kalkfontein and Warmbad the importance of the transport route from Steinkop to Warmbad becomes smaller and is no doubt destined to vanish; indeed, it is said that it is only maintained in its present low degree by the high railway rates prevailing on the line from Lüderitzbucht.

The track from Raman's drift to Warmbad ascends through the heavy sand of a river-bed to an elevation of about 2400 feet, near which it remains until Warmbad is left behind. The flora was frequently richer in individuals, and perhaps in species, than that to the south of the river, but the same forms are predominant—it is the flora of the sandy plains of Bushmanland with *Aloe dichotoma* and other Namaqualand Montane species on the hills.

In the neighbourhood of Warmbad, an important military depôt, less rain had fallen than in the surrounding country, and the vegetation was very dry and withered. This appears to be frequently the case. Sir James Alexander in 1836 experienced heavy rain in this region, but he records that "the rain-cloud passed by the unfortunate Bath as usual."* The mean annual fall at Warmbad is about 108 mm.† The settlement, formerly known as Nisbet's Bath, is situated in a slight depression (2340 feet)† on the banks of the periodical stream, the Hom, a tributary of the Orange river. It derives its name from the hot springs which issue in the rocky bed of the river, and yield a copious supply of water (35° C.), strongly impregnated with sulphuretted hydrogen. Fruits (including the date) and various vegetables are grown under irrigation in the river-bed below the town.

Warmbad to Keetmanshoop, Jan. 29 to Feb. 11. Kalahari.—Eighteen miles north of Warmbad the road ascends slightly to Dabaigabis (Dubbeeknabies of Alexander), and here some change in the flora was encountered. A bush formation—*Rhigozum trichotomum*, *Cadaba juncea*, *Acacia detinens*, shrubby Zygophyllaceæ, *Parkinsonia africana*, *Tamarix articulata*, with trees of *Acacia horrida* and *Euclea Pseudebenus*—occurs, mainly along the dry sandy river-beds. On the flat sandy ground at higher levels, Bushmanland grasses and Mesembrianthema prevail and, with them, scattered but very numerous trees of the camel-thorn, *Acacia*

* J. E. Alexander, 'An Expedition of Discovery, etc.,' vol. 1, p. 202. London: 1838.
† 'Taschen-Buch für Süd-West Afrika, 1909,' p. 225.

Giraffæ; on the branches of this tree are frequently seen the remarkable "colonial" nests of the small finch, *Philetærus socius*.* These are constructed almost entirely of local grasses. Where the soil is saline, grasses are replaced by halophytic and karoid species, such as *Augea capensis*, *Euphorbia spp.*, Mesembrianthema and fleshy-leaved Chenopodiaceæ. Dunes of moving sand are passed at intervals. The road to the north, having the Great Karas Berg within sight to the north, ascends to about 4000 feet, on an extensive sandy plain falling gently to the east. Here the vegetation is markedly karoid; *Aloe dichotoma* is absent from the numerous broken kopjes, and *Acacia Giraffæ* is almost confined to the river-beds.

On descending again to 3000 feet (Sabiesis), *Aloe dichotoma* and *Euphorbia virosa* reappear on the hills and, with them, occurs a small Capparidaceous tree not hitherto met with. The usual Euphorbia scrub occupies the lower slopes; with the latter are found Acanthaceæ (*Blepharis spp.*), Ascelepiads, *Cadaba juncea* and *Bauhinia garipensis*; the latter frequently bears a Loranthus which is very common on various constituents of the Orange river bush. In sandy ground around the water-hole, there occur most of the Orange river trees and shrubs.

A short distance north-west from Sabiesis the broad sandy valley up which the road passed, was scored with water-channels of recent origin (February 2), and the vegetation was for some distance remarkably rich. Bushes of *Rhigozum trichotomum* and *Bauhinia garipensis* were in flower and fruit, and the sand and gravel were carpeted with Monsonias, Wahlenbergias, *Tribulus spp.*, small Acanthaceæ, numerous petaloid Monocotyledons, grasses and crowds of young seedlings. But a mile or two farther on, almost the only living plants were large round bushes of the Bushmanland Euphorbia, first seen at Aggennys, closely gregarious over a large area. *Cataphractes Alexandri*, a Bignoniaceous shrub which is very common at higher levels in Damaraland,† occurred here and was frequently seen farther on towards Keetmanshoop. White butterflies, which had appeared in myriads here and there since entering Bushmanland, were still common. At Sabiesis, Seeheim and elsewhere, natural cuttings showed thick beds of sandstone with, here and there, beds of black limestone overlying the igneous rocks; intrusions of dolerite were common. Certain changes in the vegetation corresponding with these differences of geological structure will probably be shown when the collections are worked out. Apart from these, the southern floras persist as far north as Keetmanshoop (3300 feet), where they have already become incorporated with new forms (including species of Acacia) of northern affinity.

At Holoog the ox-waggon was abandoned, and the remainder of the

* Sclater and Stark, 'The Birds of South Africa,' vol. 1, p. 152.

† Pearson, Kew Bulletin, 1907.

journey to the coast was made by rail. Holoog was, in February, 1909, near the southern end of the line from Seeheim, which was expected to be completed as far as Kalkfontein a few months later. It is of the same gauge as the British South African Government railways. Seeheim, a small white settlement which has come into existence with the railway, is situated in the valley of the Fish river, an important tributary of the Orange river. This periodical stream was in flood in February, and some miles' length of the railway, laid practically in the bed of the river, was washed away. Excluding irrigation furrows and the trickles of water originating in various weak springs and ending in small pits of stagnant water, the Fish river was only the second running stream seen since leaving Ceres on November 27, 1908. No other was met with in the further journey to Lüderitzbucht. Keetmanshoop, the eastern terminus of the line from the coast at Lüderitzbucht, is the headquarters of the southern military command. It is a small straggling town, with a large native location, built on a plain dotted with Acacias; most of the other vegetation near the town has been destroyed by stock. To the south-west, about 10 miles away (Gobas), is a range of black limestone hills scored from base to summit by numerous vertical bands of intruded dolerite on which the vegetation is very poor.

Keetmanshoop to Lüderitzbucht, Feb. 12 *to Feb.* 24. *Kalahari, Namaqualand Montane Region, and Littoral Desert.*—The Aggennys Euphorbia is exceedingly abundant on sandstone between Zandverhaar and Buchholzbrunn (3300 feet), and with it grows in some quantity the common Bushmanland species, *Rhigozum trichotomum*. On the hills in the same locality, *Aloe dichotoma* is abundant. Over a wide extent of country between Buchholzbrunn and Kuibis the surface is covered with large angular blocks of quartzite. This tract is almost destitute of bush, and the vegetation is usually composed of grasses, petaloid monocotyledons and small annuals which obtain a roothold in the soil between the quartzite blocks. In the deep gorge 1 mile east of the station at Kuibis, the quartzite can be seen in section capping the gneiss. Stretches of sand and limestone occur here and there. In the sand *Ophioglossum vulgatum* is fairly common, its rhizomes lying a foot or more beneath the surface. In the Kuibis gorge there is a good water-supply, and most of the Orange river trees flourish. In this gorge was formerly one of the trading stations of Lüderitz, the first merchant to penetrate this country from the coast, and after whom the inlet named by the Portuguese "Angra Pequena" is now called Lüderitzbucht. The gorge of the Akkam river lies about 5 miles south of Kuibis, which it resembles in geological structure. Rain had recently fallen and a rich collection of plants was obtained there. At Shakals Kuppe the line ascends to 4800 feet, while the hills in the neighbourhood exceed 5600 feet. All species of Acacia as well as *Aloe dichotoma* are absent. *Rhigozum*

trichotomum, *Tribulus spp.*, *Monsonia sp.*, various Euphorbias and other Bushmanland species occur on the sandy plains; but the hilltops bear many Composites, and the flora is closely related to that of the Nieuwveld mountains in Cape Colony. Shakals Kuppe, whose rainfall normally occurs in March and April, had received rain this year (1909) in January, and the vegetation therefore in February was in an unusually good condition. Large herds of springbok were in the neighbourhood. Wild ostriches were seen on the plains to the west of the ridge, between Shakals Kuppe and Aus. Here, a drought of several months' duration was still unbroken, and the plants were for the most part dried up and wide stretches of ground were bare of vegetation. Shakals Kuppe is situated a little to the west of the limit of the night mists, which occur chiefly during the winter months; the summer fogs do not usually form so far inland as Aus.

Although Aus stands a few feet higher than the railway station at Shakals Kuppe, the higher ground a little to the west of the latter is apparently on the main watershed. West of this line the vegetation becomes more karoid in appearance—a fact which is only partly explained by the absence of annuals due to the drought. On the barren hills around Aus, which previous to February 20, 1909, had been rainless for several months, the predominant species appeared to be the bushy Mesembrianthemum which occurs in abundance in some parts of western Bushmanland, notably south of Kietfontein. West of Aus, the line descends rapidly, and passes from sedimentary strata to the underlying granite and gneiss which form the surface rocks thence to the coast.

Below Aus, the hills, and later the sandy valleys and plains, become more and more barren until the desert-edge is reached. *Acacia Giraffæ* and even *A. horrida* are still represented in places where underground water would be expected to collect. *Ophioglossum vulgatum* was found widely spread in the sand, on which, as a result of heavy rains fourteen days earlier, many young seedlings gave promise of later luxuriance. The sudden appearance of seedlings a few days after rain is a remarkable characteristic of these dry regions. There can be no doubt that the seeds of annuals must in some cases retain their power of germinating through a series of years of drought, and the possession of this character is probably a determining factor in the persistence of many short-lived species. It is noteworthy that a considerable proportion of these belong to the family Leguminosæ in which species with long-lived seeds are numerous.* On the other hand, it should be remembered that outside the limits of the desert proper, a district which has been rainless for some time is usually not far removed from another in which the conditions have been less severe, and from which living seeds might easily

* Cf. F. F. Blackmann, *New Phytologist*, 1909, p. 31.

be conveyed by wind or some other agent. Although the vegetation in this locality was too young to allow of a thorough study of its composition, it was clear that many characteristic Kalahari species had crossed the watershed and were established under soil conditions almost identical with those that occur on the plateau.

The eastern edge of the desert is marked by what Schinz has described as a Euphorbia-steppe, of which constituents of minor importance are *Aloe dichotoma*, *Sarcocaulon sp.*, *Hermannia sp.*, *Zygophyllum sp.*, and *Acacia Giraffæ*, the latter represented only by a few dwarfed specimens. This zone is crossed near the station, Gorup, about 70 miles from the coast and 17 miles west of Aus, at an elevation of 2700 feet. The change from the karoid semi-desert in the neighbourhood of Aus to the true desert at a lower elevation seems to depend primarily upon the configuration of the land. The western edge of the plateau on which Aus is placed is high enough to precipitate rain from the sea winds. The clouds so formed do not extend westwards so far as Gorup, and the water which reaches this station is mainly in the form of surface drainage from the western slopes of the plateau. After a drought lasting several months, a violent thunderstorm broke in the vicinity of Aus on February 20, 1909. The sandy plain to the west of it was covered by a sheet of running water strong enough to make the railway unsafe, while sheets of rain fell as far as 11 miles west of Aus. But at Gorup, 3 miles further down, the sun shone unobscured all day and not a drop of rain fell.

The geological structure of the desert belt does not differ essentially from that of the higher country west of Aus. Gneissic and granite domes, peaks and ridges emerge from enormous accumulations of sand blown up from the lower-lying plains which are unprotected by vegetation. The flora of the desert is closely allied to that occurring on the western slopes of the plateau, though much poorer in species. These tend to decrease further west, and the poverty of the vegetation is nowhere more strongly marked than on the severely arid rocks and sand-dunes behind the town of Lüderitzbucht. Schinz has pointed out that the flora of the desert in Great Namaqualand, in the latitude of Lüderitzbucht, is poorer than that of Damaraland, north of the tropic. He believes that this difference is accounted for by the presence of a more copious supply of underground water in the northern area. While it is probable that this conclusion is well founded, there may also be other factors whose influence tends to increase the effects of the differences in subterranean humidity. According to Stewart,* the eastern limit of the belt in which at least 50 per cent. of the rainfall occurs in the winter months crosses the Orange river in longitude 17°·8, and probably emerges on the coast near the 25th parallel of

* C. M. Stewart, 'Science in South Africa,' p. 19. 1905.

latitude, *i.e.* a little south of the southern side of Walfish bay. If this is correct, such rain as the Namaqualand desert enjoys falls mainly in the winter, while the adjacent western edge of the plateau has a summer rainfall. It is quite conceivable that a smaller number of species derived from the plateau with a summer rainfall can become adapted to the conditions of a desert with an infinitesimal winter fall than to one in which, as in Damaraland, the little rain that does fall comes in the summer. There is also to be considered the fact that the Damaraland desert area meets in the north and east respectively the highlands of Ovamboland and Damaraland, possessing a richer flora than that of the Great Namaqualand plateau; it is thus able to draw its supplies from a wealthier source than is available farther south. In this connection it is significant that in the desert belt north of the Swakop, species of tropical affinity not found behind Lüderitzbucht constitute an important part of the flora.

The country between the Lüderitzbucht-Aus railway line and the lower course of the Orange river is a desert of the most severe type; it is uninhabited save for a few Bushmen and Hottentots, who are found chiefly on the northern bank of the river. Dr. C. Range,* Government geologist in Great Namaqualand, has penetrated this desolate region in certain directions from the east and north. He has made the most interesting discovery that *Welwitschia mirabilis* occurs in the southern part of Great Namaqualand, and is represented by a number of small plants as far as 31 km. south of Gorup. This locality, found quite by accident, is very difficult to locate and, owing to the total absence of surface water, still more difficult to reach. This observation extends the distribution of Welwitschia about 200 miles to the south of its previously recorded southern limit.† Dr. Range also confirms the statement of Th. Hahn, that the "Naras" (*Acanthosicyos horrida*) occurs on the sand-dunes near the mouth of the Orange river (see p. 485).

Between Rotkuppe (1000 ft.) and Lüderitzbucht, the mountain system is very complex; it bears so little vegetation that it produces an impression of extreme desolation. On the long wind-swept slopes of sand leading up to the mountain bases, plant-life is only represented by a species of Sarcocaulon with a bright yellow cuticle, thousands of which, leafless and without flower, present a remarkable appearance. Elsewhere, Euphorbia bushes are dotted over the surface. In the sand which collects in large dunes in the hollows on the hilltops, the vegetation is sometimes richer and includes grasses, *Pelargonium sp.*, *Pituranthos aphylla*, shrubby Asclepiads, and Mesembrianthema. It is

* I am indebted to Dr. Range for kindly permitting me to make use of this information.

† Pearson, Kew Bulletin, 1907, p. 347.

SOUTH ANGOLA. INSPANNING OXEN IN THE ACACIA FOREST BETWEEN GAMBOS AND TCHIPELONGU. THE DRY SEASON HAS COMMENCED (MAY, 1909), AND THE GRASSES ARE ALL DEAD.

SOUTH ANGOLA. AN "OUT-SPAN" BENEATH A LARGE FICUS IN AN OPEN GRASSY GLADE NEAR KIHITA.

a matter of common observation that the sea mists are denser and more enduring on the hilltops than lower down; consequently the conditions are there less unfavourable both for seed-germination and for root-absorption, and also the daily period of strong insolation is shorter than on the plains below.

Moving sand-dunes have occasioned very serious difficulties in railway construction in the lower part of the desert strip. The cultivation of sand-binding plants has been unsuccessful and, to prevent the advance of the sand across the railway line, various mechanical devices have been resorted to. Walls of stone and corrugated iron have been built across the direction of the prevailing winds and the windward slopes of many large dunes are carpeted with matting. In spite of all these, large bands of natives are continually employed in clearing the line. The wind, almost of daily occurrence, is very powerful, and it carries so much solid matter that it cannot be faced without considerable inconvenience. It carries to the hills enormous masses of the smaller granules from the lower slopes and plains, and leaves bare the fine worn gravels recently found to be diamondiferous. Diamonds are now being collected over a wide area extending south from Lüderitzbucht as far as the conveyance of food and water by camels and other means of transport is practicable. Lüderitzbucht itself is quite without fresh water. Five years ago, when what is now a busy port and a crowded township with a feverish stock exchange, was a desolate coast settlement with nine European houses, a fortnightly supply of drinking-water was brought by boat from Cape Town. Now the supply is obtained by the condensation of sea-water.

Swakopmund to Welwitsch. Feb. 27 *to Mar.* 12. *Littoral Desert.*—Damaraland was only penetrated as far as Welwitsch, a Welwitschia station 35 miles from the coast on the Swakopmund-Windhoek railway. The flora was in a much poorer condition than on a previous visit in 1907.* This is probably to be traced directly to the excessive rainfall which fell in December, 1906. The following is a summary of the meteorological records which were commenced at this station in November, 1906:—

1906.	November and December,	3 rainy days.	Rainfall,	12·5 mm.
1907.	January to June,	5 „	„	0·5 „
—	July to December,	7 „	„	0·93 „
1908.	January to June,	4 „	„	0·12 „
—	July to December,	7 „	„	2·0 „
1909.	January and February,	7 „	„	3·9 „

Nightly, throughout the year, sea fogs envelop this locality with great regularity, and are not dissipated from the highest hills until the sun is well up. These are often sufficient to discolour the sand, and to

* Pearson, *loc. cit.*, p. 344.

make it distinctly moist to the touch. But without rain the deposit from fog is unable by itself to bring about the germination of the seeds of many annuals and the full vegetative and reproductive activity of many of the perennial species. It is further probable that a rain sufficiently heavy only occurs at long intervals; here again the seeds of many species must retain their vitality for periods of years under most unfavourable climatic conditions. The flora of this district has been briefly described in an earlier paper;* a further consideration is postponed until the collections of 1907 and of the present year have been studied in detail.

Mossamedes to Humpata. April 21 *to May* 4. *Littoral Desert, Vitis Zone, Open Bush and Forest, Savannah.*—From Benguella southwards, the littoral savannah which commences south of the mouth of the Congo is continued as a dry coast-belt in which the vegetation is very sparse. The desert itself commences at about lat. 14°·22 S.† Its rainfall is greater than that of the coast-belt of Damaraland, though irregular. Exceptional rains had fallen early in the summer of 1908–09, and the vegetation in April was unusually luxuriant. The plains behind Mossamedes were grass covered and the silvery awns of a tall Aristida, the most abundant species, glistened brightly in the sunshine. Many annuals belonging to the Ficoideæ, Compositæ, Gramineæ and other families flourished in the partial shade of the Aristida. The plain between Mossamedes and Cape Negro is the classical locality in which Welwitschia was discovered by Welwitsch in 1861. About 8 miles south of Mossamedes, the plants are met with in abundance and of much greater size than those in Damaraland. As in the latter locality, they are generally situated in dry water channels, and it may therefore be inferred that the seed distribution is effected first by wind and later by water. Most of this year's seeds were infertile, but very many young seedlings of earlier years were found. Compared with the plants seen in Damaraland the inflorescence stalks are very short and inflorescences consisting of a single cone are very common. The hollows of the stem were here nearly always filled with sand, and, in this, numerous plants of the tall Aristida were usually established. The Hemipteron *Odontopus sexpunctulatus* was even more numerous on and around the plants than in Damaraland; two specimens of this insect were seen in the town of Loanda. From the numbers and size of the Welwitschias in this locality and the frequency of seed-reproduction—the seedlings were certainly of several seasons—it is clear that under existing conditions the species is more at home here than farther south in Damaraland and Namaqualand.‡ Since no other members of the family occur south of the

* Pearson, Kew Bulletin, 1907.

† Monteiro, 'Angola and the River Congo.' London: 1875.

‡ See Pearson, *Nature*, 1909, p. 499.

Kunene and tropical species of other families are found far south of the tropic in Namaqualand, it may be inferred that Welwitschia is in its origin a tropical species and therefore more closely related to the tropical members of the family—now represented by the genus Gnetum—than to Ephedra. This conclusion is confirmed by a comparison of what is known of the life-histories of the three genera.

Mossamedes, the seat of the Governor of the district of that name, has about two hundred white inhabitants; the native population is almost entirely composed of "contracted" labourers, many of whom are sub-contracted to various householders as domestic servants. The most important export of Mossamedes is dried fish, a common article of food, both with the natives and the Portuguese, throughout those parts of Angola which are in regular communication with the coast. A small quantity of sugar, from the plantations in the bed of the Bero river, is also exported. Ivory and horns, with occasional consignments of rubber from the interior, have also been shipped in some quantity. But with the temporary cessation of railway construction and the prevailing unsettlement among the Boers of the Huilla plateau, these exports, as well as imports for consumption in the interior, have considerably fallen off.

The climate of Mossamedes is famous up and down the coast for its salubrity. Frequently a period of three or four years is rainless and, except for the night-fogs, the air is dry and invigorating. In exceptionally wet seasons there is stagnant water to the north of the town, and, as in this present year, fever is of common occurrence. That the town is usually healthy can only be ascribed to the powerful influence of the sun's rays in destroying disease germs; for its refuse is dumped down on the beach a few yards from the principal street, and measures to prevent the breeding of mosquitoes are neglected. Mossamedes could be made a valuable health resort in a country in which localities suitable for this purpose are few.

A railway from Mossamedes to Lubango, the capital of the Huilla province, situated at an elevation of 5460 feet, has been surveyed; 70 miles of it is already constructed (June 1909) and a daily service of one train a day each way is established as far as 66½ miles. The gauge of this line is 60 centimetres—the same as that of the German lines which connect the port of Swakopmund with Windhuk and with the Otavi copper mines. On leaving Mossamedes the line at first runs in a northerly direction, crossing the mouth of the Rio Bero half a mile from the town and, some five miles farther on, entering the bed of the Rio Giroual. Between these two river-beds there is a station at the north end of the bay, serving as a depôt for coal and other heavy cargoes—the facilities for landing being greater here than in Mossamedes itself. Near its mouth, the bed of the river Bero is a mile or more from bank to bank. During exceptionally rainy seasons

it contains a good deal of surface water in which mosquitoes breed freely. At such times malaria is common in Mossamedes. Both here and in the bed of the river Giraul there are many Faciendas in which sugar cane and other tropical and sub-tropical crops are cultivated. As soon as the railway leaves the bed of the latter, it enters, at about 410 feet, upon a plain which is without surface water as far as the position of the present railhead—except in places where rain and dew collect, as in the hollow of the remarkable mass of granite known as "Pedra Grande."* At about 37 miles from Mossamedes there first becomes visible, at a distance of some 62 miles, the perpendicular front of the Shella range, whose summit is between 3000 and 4000 feet above the plain on which it stands. At about 27 miles from the sea, and 1100 feet above it, there commences a zone in which the predominant plant is *Vitis macropus*.† Above this zone the vegetation changes rapidly; grasses increase in number and soon cover the surface thickly; bushes of Acacias, *Bauhinia garipensis*, Acanthaceæ, etc., occur with increasing frequency; before the railhead is reached, shrubs and small trees are the most conspicuous elements of the vegetation.

Transport from the present railhead to the plateau is difficult and slow. The waggon-road is circuitous and exceedingly rough, and its passage from the railway terminus to the Boer settlement of Humpata (6100 feet) occupies seven days. There is, however, an alternative and more direct route, inaccessible to waggons, which may be traversed on foot, on horseback, or in a "tipoia," in three days or less. This road ascends gradually for 25 or 30 miles, at the end of which we are 3300 feet above sea-level and at the foot of the Shella range. Here the path enters a most picturesque pass, which gives access to the Huilla plateau. A few miles from the foot of the pass is the fort of Kapangombe, erected about 1860, now practically abandoned. Near it is the store, kept by a half-caste Portuguese, now probably even more deficient in goods than when it was visited by the Earl of Mayo in 1882.‡ It is situated in an open forest dominated by the "Mutiati" tree, *Copaifera Mopane*, whose fibrous bark provides the native with a most efficient substitute for rope and string, and the Baobab (*Adansonia digitata*). In the neighbourhood are a number of Faciendas largely devoted to the cultivation of cotton.

From this point there is obtained a fine view of the perpendicular edges of the beds of sandstone which form the upper part of the range. Along the skyline appears dense vegetation, but the precipitous face seen from this distance is bare and grey. The outcropping strata are

* See Monteiro, *l.c.*, vol. 2, pp. 221, 222. Monteiro here gives a general account of the geology of the coast-belt along this route.

† See p. 485.

‡ Proceedings of the Royal Geographical Society, vol. 5 (1883), p. 458.

horizontal, and from this point of view the Shella range is extraordinarily like the front of Table mountain as seen from Table bay, but on a much larger scale. From September to April the top of the range is very generally enveloped in cloud, and thunderstorms are of frequent occurrence in its neighbourhood, particularly towards evening. By the beginning of May the rains have usually ceased. On entering the kloof, the path runs through fairly dense forest, in which giant Baobabs, now losing their leaves, are the predominant constituents. Above the forest, on either side, is a perpendicular wall of rock, perhaps 2000 feet high, on the face of which a few scattered shrubs retain apparently precarious footholds. As illuminated by the setting sun, the rock-face is no longer grey, but presents a gorgeous combination of orange, yellow, pale green and dull blue shades, indicating a rich growth of lichens. The path is rough, but shaded by the walls of vegetation which bound it. Here it runs alongside a coffee-plantation with heavily laden orange trees; farther on it follows the course of a mountain torrent, and is lined by rich masses of maidenhair and other ferns; near the top the grasses increase in number, and there are encountered gnarled trees and low bushes of Proteaceæ constituting the most striking elements of the flora of the savannah which occupies the main extent of the plateau. The magnificent view of the plains to the west which is obtained from the top of this pass has excited the admiration of every traveller who has ascended it.*

Humpata (6100 feet) is situated about 12 miles from the summit of the pass, in a north-easterly direction. The climate of the plateau is, for the white man, one of the finest in Tropical Africa. The winter season is dry, with bright sunny days and cold nights in which the temperature commonly falls below the freezing-point. A sufficient supply of good water is available all the year round and mosquitoes and fever are absent. Humpata and Lubango are important headquarters of the small Boer community which has been settled on the plateau since 1881.† Lubango is also the seat of administration, and the residence of the Governor of the Huilla district which extends across the Kunene to the German frontier. The Boers, who at the present time are estimated to number about one thousand, have been engaged mainly in hunting and cattle-breeding—cattle having been largely employed in transport to and from the coast and the interior. A little cereal cultivation (principally wheat) has also been carried on, but agriculture in general has received little attention. Various circumstances have caused some degree of dissatisfaction with Portuguese rule, and this, with the retreat of the game and the decline in the demand for ox-waggon transport—which will become more marked

* Cf. Earl of Mayo, *loc. cit.*

† Pearson, 'The Boer Colony in Angola,' *Morning Post*, December 25, 1909.

as the railway construction proceeds—have led many of them to desire to return to the home of their fathers in the Transvaal. The exodus, by sea, has already commenced and is likely to continue until a considerable proportion of the colonists have become repatriated. This will not be without its effect upon the Portuguese administration, for the Boers have, directly and indirectly, done a great deal to quell the native opposition to the extension of an effective Portuguese occupation down to and beyond the Kunene. When their influence is diminished or removed entirely, the difficulties of maintaining an effective control throughout the district will be greater than they have been in the past.

Humpata to Fort Rosadas, May 10 *to May* 21. *Savannah, Open Forest, Marsh.*—As a consequence of a series of military operations which have been in progress recently against the Ovambo tribes north of the German border, there are at present well-beaten tracks from the plateau down to the Kunene, following for the most part the course of the Kakulovar, which joins the Kunene a little below the position of Fort Rosadas. This route is now well known, and its general features have been described by the Earl of Mayo,* Baum † and other writers; its flora, however, which appears to be very rich, has been but little exploited. The whole region has a summer rainfall, which is frequently heavy and, on the lower ground bordering the Kunene, causes extensive floods. The rains normally cease early in April, and in the winter season, which is rainless, the ground becomes dry and hard as iron. In the summer there is much fever below 4500 feet, and this of a somewhat virulent type. Sleeping sickness is not known so far south. After the rains have ceased, the water-supply becomes scarce and all that is available between Gambos and the Kunene is usually more or less discoloured and fetid, and, even after filtering and boiling, cannot always be drunk with impunity. The open Proteaceous forest of low trees and bushes with an undergrowth mainly of grasses descends as far as Shibia; below this it gives place to an open forest in which the leguminous *Copaifera Mopane*, the Baobab, and various Acacias in turn predominate. A few species of Ficus, mostly tall and handsome trees, are present. Two palms become fairly common in the more open country near the Kunene. Epiphytes and lianas are rather rare, though the latter perhaps occur somewhat more frequently than would be expected from the open character of the forest and the length of the dry season. Many of the trees are deciduous; of these the Baobab, which is well known to be a light-loving tree, is practically confined to open glades, in which it spreads its huge leaf-bearing branches above the level of the surrounding forest. The undergrowth during the wet season is mainly composed of a dense growth of grasses, among which the genus Aristida

* Cf. Earl of Mayo, *loc. cit.*

† H. Baum, 'Kunene-Zambezi Expedition.' Berlin: 1903.

is conspicuous; these die down as the dry season advances. Next in importance to these are small gay-flowered bushes of the family Acanthaceæ and numerous small Leguminosæ (among which the genera Indigofera and Dichilus are important), mostly prostrate or climbing. Within recent years lions and other large game have almost disappeared, and animal life is no longer conspicuously abundant. Crocodiles are abundant in the Kaculovar and the Kunene; guinea-fowls, apparently of two species, are met with in large flocks, and at sunrise the forest resounds with their cries. Snakes are rarely seen, but scorpions abound in the hot sand of the dry river-beds.

Except in the immediate vicinity of the mission stations, few natives are seen along the transport roads, though fields of millet—the most important native crop—and recently abandoned clearings show that inhabitants are in the neighbourhood or have recently left it. Their absence from the vicinity of the road is no doubt due, in some part, to the demands made upon them for food and other commodities by an impoverished and disorderly soldiery on their way to the front, and to their dislike for compulsory service as labourers or carriers, which is still enforced very much as it was in 1854, when it was described in the Golungo Alto District by Livingstone. The Gambos natives (west of the Kunene) are a simple people, shy, but easy to deal with when they are properly treated. Many of them show a distinctly Egyptian cast of countenance. They are small of stature, and both men and women present the appearances of advanced age while they are yet young in years. The dress, both of men and women, consists of a short petticoat depending from a waistband. European clothes are eagerly adopted as opportunity arises. Charms or fetishes of various kinds are suspended from a leather thong round the neck; in the case of natives under the influence of the missions, an iron cross finds a place among them. Usually a necklace of large coloured beads is also worn. Men and married women adopt a remarkable style of hairdressing. The hair is incorporated in a thick mass having the consistency of fresh putty; this substance is composed of clay, ox-fat, an oil obtained from a seed (said to be that of *Ximenia americana*) and a red vegetable colouring matter ("mumbiri"). The form of the mass varies considerably, being usually more complex in the case of the women. But whatever its form it always projects over the back of the neck, and so undoubtedly affords some protection against the rays of the sun.

The French Catholic Mission of the Order of "*Le Sacré Cœur*" has established mission stations along the route at Huilla, Shivinguiro, Kihita, Gambos, and Shipelongo. An extension to the south-east among the trans-Kunene Ovambo tribes is contemplated. Each mission station is surrounded by a native settlement. At Huilla, the principal station, there is a large industrial establishment attached to the mission, in which about eighty natives are employed in various skilled trades—

tanning, boot-making, tailoring, carpentering, masonry, iron-working and printing; waggon-building and repairing, for the Boers on the plateau, is an important branch of its work. A steam engine—of the portable type ordinarily used in agricultural operations—has been brought over the plateau from Mossamedes by native carriers and set up on the premises; it is employed in cutting wood, breaking up the bark used in tanning (*Berlinia sp.*), grinding corn, and in lathe work. There is a large garden well stocked with European vegetables and fruit-trees; a section is devoted to the experimental cultivation of exotic trees and of native plants reputed to be of use for medicinal and other purposes. The upper part of a small observatory is devoted to meteorological work; in its lower storey there is a collection forming the nucleus of a museum illustrating the zoology of the district. The names of Fathers Antunes and Dekindt are associated with important botanical investigations on the Huilla slopes; these are being continued by the present Father Superior.

Apart from the missionaries and the garrisons of the forts, there are few white settlers between Shibia and Humbe. These are engaged in cattle-breeding and transport-riding. Between Ediva and Humbe an extensive experimental cultivation of cotton was commenced two years ago by an Anglo-French company.* It is yet too early to judge of the quantity and quality of the yield, or whether any profits will be left after the cost of the long transport to the coast and the heavy export dues are paid; but it is encouraging that those immediately interested are confident of success. If this is achieved, cotton cultivation will be capable of great development on both sides of the Shella range.

Humbe is situated on the low ridge dividing the valley of the main stream of the Kunene from that of its tributary, the Kakulovar. On crossing the latter from the west, the forest becomes more open, and the approach to Humbe lies through a scrub of low Acacia bushes. Beyond the village, consisting of a fort, a magistrate's office, a store and a few huts, the country is open. The most striking plants are a giant Euphorbia (20 feet high), a Ficus, the Baobab, and an acaulescent palm (*Hyphæne sp.*). The bank of the Kunene, opposite Fort Rosadas, is about 6 miles east of the Humbe ridge. In the dry season waggons traverse the whole distance without difficulty, but before the summer floods have subsided a belt of lowlying land on the west side of the river, from 1 to 2 miles wide, is submerged and must be crossed in boats. At the end of May of this year the water was still too deep for waggons and yet too shallow for boats. It was therefore necessary to wade through a marsh infested with crocodiles for a distance nearly as much as a mile in order to reach the river itself. Thick beds of

* Pearson, *Gardeners' Chronicle*, 1909, p. 415.

reeds cover extensive areas of the marsh; an Azolla, a Marsilia and a particularly fine species of Utricularia were found in the more open pools, though the season for aquatic plants was almost passed. Isolated trees (*Ficus sp.*, etc.) occur on the higher ground away from the river.

The current of the Kunene, about 100 yards from bank to bank, was very strong; the crossing was effected in a small, flat-bottomed iron boat whose accommodation is insufficient to cope successfully with the heavy transport, military and civil, which reaches the river at this point. Oxen are made to swim over, a gun being fired at each crossing to scare away the crocodiles. Fort Rosadas, on the opposite bank, has a commanding position on a high chalk cliff overhanging the river. Until recently it has been the frontier fort; as such it has witnessed many hard-fought engagements between the Portuguese and the warlike Ovambo tribes who occupy the country to the south. The vicinity of the fort is extremely unhealthy—a condition largely due to the utter neglect of the most elementary sanitary precautions. That no improvement in these matters had yet been effected was proved by the presence of the decomposing body of an ox and other organic refuse within a short distance of the walls of the fort. The mortality among white troops stationed there has been so great that it will in future be occupied only by native soldiers.

The forest flora of Gambos and Humbe recommences a mile or two from the left bank of the river. This region, as far as Humbe, has been traversed by Schinz* in the course of his journey northwards from Great Namaqualand. He states that *Copaifera Mopane* has its southern limit at about 20° S. lat., and that other important elements of the flora extend further to the south-east into Ngamiland; to the south and south-west, however, many of these give place to species of Acacia, the dominant trees and shrubs throughout the highlands of southern Ovamboland and Damaraland.

The PRESIDENT (before the paper): The lecturer to-night, Dr. Pearson, has every right to speak on botanical subjects with authority. He is Professor of Botany at the African College at the Cape, and is in charge of their herbarium. After taking an excellent degree at Cambridge, he went as travelling student to Ceylon, and on his return from his journeys, he was appointed Chief Assistant at the Royal Gardens at Kew. He has, I think, made three journeys in those parts of Africa about which he is going to speak to-night, mainly with a view of searching for the welwitschia, an exceedingly interesting plant. But although he has perhaps been interested in questions connected with the geographical distribution of plants, I feel quite sure that before this lecture is over you will agree with me that he has always kept his eyes open for all other geographical questions, and that we shall hear a great deal of interest about these desolate and interesting countries.

Sir SOMERSET FRENCH: I am sure we have all listened with the greatest

* Schinz, *loc. cit.*

interest and pleasure to the lecture which has been delivered by Prof. Pearson. I cannot claim to have had any personal experience of the parts of South Africa about which he has been speaking, as they are far distant from those portions of the Cape Colony which are generally visited by travellers and others, but I hope that no one here to-night will form the impression that Bushman Land is in any way typical of South Africa as a whole. It is certainly very interesting from a botanical point of view on account of the peculiar vegetation which is found there, and which differs, as we have heard, in many respects from the prevailing types in other parts of South Africa.

It will perhaps interest you to know that, owing to the sandy nature of the soil and the desert-like character of the country generally, the Cape Colony Government some years ago decided to introduce camels for police and transport purposes. You will hardly be surprised at this, after hearing from Dr. Pearson that the water-pools upon which human and animal life is dependent are generally about 60 miles apart. At several places along the border of German South-West Africa the police-patrols, who, we have been told, generally consider a messenger a safer means of conveying important intelligence than the heliograph, are mounted on camels; and the post which runs between Zwart-Modder and Rietfontein on the German border is also conveyed by means of these animals.

There are other points of interest which I might dwell upon, but unfortunately, not anticipating that I should be called upon to speak this evening, I did not bring any notes with me. I think, therefore, I had better make way for some other speaker who is in a better position than I am to continue the discussion.

Dr. O. Stapf: I have followed with much interest Prof. Pearson's account of his journey, which will, no doubt, form a very valuable contribution to the physical geography of South-West Africa. I am saying this not only under the impression of what we have heard from him, but also from my knowledge of his collections, which are at Kew, where they will be worked out. It is, of course, quite impossible to deal here in detail with the many questions which arise in connection with his paper, but I should like to make a few general observations. We have gradually come to the conclusion that, speaking very broadly, the flora of South Africa, with the exclusion of the extreme South-West, but including the Cunene and Zambesi basins, and that of East Africa, exhibit sufficient affinities to justify us in treating them as one great phytogeographical province, the East and South African Steppe Province, as Engler has termed it. What Prof. Pearson has told us agrees well with this great generalization. On the other hand, considerable uncertainty exists as to the exact character and extent of the subdivisions of this area, and it is in regard to these that I expect most from his collections and observations. To mention only one example, I would point to his account of the existence of the "Composite" flora—I hope he will find a less inconvenient term for that flora—on the mountains of Great Namaqua Land. We should, no doubt, have been able more or less accurately to deduct that and similar facts from his collections by tabulation. But how wearisome is not this process, and how bare the result, compared with the observations made on the spot by a well-trained field-worker like the lecturer, who takes the facts in with a glance, and at the same time sees them in their full natural setting? In saying this, I do not wish to speak disparagingly of the laboratorium and herbarium work at home, work which after all supplies the field-worker with the necessary means for correctly analyzing and co-ordinating his observations. But if Prof. Pearson's success is to a great extent due to his previous training in the laboratorium and herbarium, it stands to reason to wish that the laboratory and herbarium man should have his share of training in the field before he finally settles down to home work, which otherwise is apt to become narrow and

dry. In accepting Prof. Pearson's paper, which contains so much botanical matter, your Society may seem to have gone somewhat out of its way. If this should be so, we botanists, at any rate, have reason to hail the occasion as proof of the recognition on your side of the importance which attaches to plant-geography in its relations to the problems of physical geography.

The PRESIDENT: When you see Dr. Pearson's paper in our *Journal*, you will find that it contains a vast amount of information about the flora of this region, and that it certainly is a paper which must be consulted by any one who wishes to study the geographical distribution of plants in this part of Africa. I think he has been wise to-night in giving us a general description of the country, whilst merely introducing the botanical element to the extent that the non-botanical mind can follow. I must confess that the remark which will remain longest in my mind is one which Prof. Pearson made to me before the lecture. I do not pretend to repeat it exactly in his words. We were talking of golf, and he said that this country is the worst in the world for putting greens and the best country in the world for bunkers. It would be difficult in as few words to give a more accurate description. Seriously, Dr. Pearson has given us an extraordinarily vivid picture of this arid region, and I am sure you will wish me to thank him most heartily for his most interesting lecture.

Prof. PEARSON: I have to thank you very much for your kindness. I should like to say that the expedition which I have had the honour of saying something about to-night was carried out under the auspices of the Percy Sladen Trustees and the Government Grant Committee of the Royal Society.

EXPLORATIONS IN BOLIVIA.*

By Major P. H. FAWCETT, R.A. (retired).

FROM time to time short accounts of the explorations and boundary work with which I have been associated in South America have been contributed to the *Journal* of this Society, whetting the appetite, perhaps, of those interested in such work for more information regarding this neglected continent.

In this particular paper I have endeavoured to embody in a very limited space three objects: firstly, a general idea of Bolivia as it is to-day, apart from political questions and existing commercial conditions which can be found elsewhere; secondly, an insight into the nature of exploration in the uncivilized regions of this little-known continent; thirdly, a short personal account assisted by lantern slides of the explorations which I have conducted on the borders of Bolivia and Brazil, together with the results that have been achieved.

Bolivia is the Switzerland of South America, cut off from the sea, and lying roughly between 10° and 23° S. lat. and 57° and 73° W. long. It possesses an area of something over 650,000 square miles, or over five times that of the United Kingdom. Speaking generally, it can be divided into four zones: the Altiplanicie, or high plateau west of the main Cordilleras, 11,000 to 14,000 above sea-level; the Cordilleras,

* Royal Geographical Society, March 14, 1910. Map, p. 620.

or deep mass of snow-capped Andes, whose main peaks have attracted considerable attention of late years; the sub-tropical abrupt eastern slopes; and the more or less tropical plains which form portion of the basin of the interior South American water-system.

West of the Cordilleras the country is practically bare of vegetation, except where cultivated in the neighbourhood of the great lakes and in the valleys of the Andean rivers. East of the Cordilleras is a region of forest and vast campos or grass plains. With the exception of a few unimportant streams which empty themselves into the great lakes of Titicaca and Poopoo, all the rivers flow from or through the Cordilleras into the basins of the Amazon or Paraguay.

Bolivia is exceedingly rich in natural resources, and is progressing with that remarkable rapidity which seems to have overtaken the southern republics of the continent during the past decade. It is handicapped by its small population of under two millions, of which one half is Indian, one quarter mestizo or mixed, one eighth white, and the rest nondescript. The census is not very reliable. This population is centred upon the Altiplanicie and in the towns and villages of the south centre; the remainder is distributed thinly along the banks of the principal rivers and upon the scattered fincas of the Cordilleras. As behoves the descendants of the Spanish conquerors and the old Incan empire, the race is strong, virile, and intelligent.

Indian ethnological details are most complex. West of the Cordilleras are the Quichuas and Aymaras, descendants of the Incan empire; east an infinity of small tribes distinct in feature, language, and customs. Hovering on the confines of civilization are the savages, debased and intelligent, dwarfs and well developed, usually cannibals, and preserving a revengeful hostility against everybody outside their own tribe. In the heart of the continent they are beyond the pale of communication, and their origin is shrouded by that veil of conjecture behind which lies all Indian history prior to the last Incan dynasty. Many explorers and expeditions have entered their forests, yet practically nothing is known of their customs. The tale of tragedies and lost expeditions is a very long one, for they are treacherous and merciless to those whom they consider their hereditary foes.

Communication within the republic is improving yearly by the extension of railways. La Paz is in railway communication with Antofagasta in Chili and Mollendo in Peru. A railway from Arica to La Paz is under construction. Branches are being pushed out to Cochabamba and Potosi; and other projects, including a transandine line, are under consideration, and will be carried into effect within a few years. La Paz thus becomes the pivot of the Bolivian railway system, which ensures it being the centre of all future development. It is expanding by leaps and bounds. Fine buildings are springing up; the city is extending down the valley; it is electrically lighted; and

there is a good tram service. Broad-minded legislation and municipal enterprise will, in the near future, make it the Garden City of the Southern Pacific—a Mecca of the Andes for tourists who can appreciate the grandeur of mountain scenery and the historic romance in which these highlands are steeped. It has a dry, invigorating climate, and sanitary improvements are proceeding apace. Fairly good roads connect all the larger towns. Across the passes of the Cordilleras are mule-tracks following the long hog-backed ridges which extend like the tentacles of an octopus into the eastern forests. East of the Cordilleras communication is usually by water, as soon as the mountain torrents settle down into reasonably safe navigability. Beyond these waterways, and excepting amongst the group of rubber properties which patch the north-eastern and eastern frontier regions, is virgin forest. There is no portion of the country from north to south and east to west which, with an assured market, can be reckoned undesirable for the immigrant. Much of it is mineralogically and agriculturally a paradise.

The climate, except on the extreme frontier, is not unsuitable for a white man. Everything grows luxuriantly. On the great grass plains which lie inside the belts of rich forest bordering the rivers, there is ample scope for cattle-raising. There is practically an unlimited field for the prospector; and the rifle can be relied upon for food within the limits of the Amazonian forest. There are Englishmen and other foreigners dotted about the eastern slopes of the Andes to-day leading a profitable Arcadian existence free from anxieties and taxation of any kind. For the lucrative exercise of skilled craftsmanship there is splendid opportunity for the man who does not drink and will learn the language.

Now, the interior of South America is largely unmapped, or incorrectly mapped, and in vast areas still unexplored. All the main rivers have been traced for the greater part of their courses, and certainly all those easily navigated. But outside of that area on the principal rivers of the interior occupied by rubber exploitation absolutely nothing is known of the country a hundred yards from the river-banks. When that intrepid explorer, Chandless, ascended the principal tributaries of the Amazon in a canoe with only three or four peons, in the sixties to be more precise, the wild Indians were not so markedly hostile as they are to-day. Indeed, he was usually well received and fed. Since that time the savage has been sacrificed to rubber; slaughtered often under circumstances of horrible barbarity; his villages burnt and his farms destroyed; either to secure forced labour for the rubber estates, or to exterminate him from the field of its exploitation. These methods have long ceased to receive official encouragement. But to-day a perpetual war of reprisals is being waged between civilized and savage; and this revengeful hostility constitutes one of the greatest dangers of South American exploration. It is more

than doubtful if the really wild Indians of South America are amenable to civilization as understood by those with whom they come into contact. The time will come when they must have their recognized reserves or disappear.

Regarding the natural resources of Bolivia, one hesitates to court a suspicion of exaggeration. I have no personal doubt that it is a commercial Eldorado of the future. On the Altiplanicie there are coal and copper, and much undeveloped tin and silver. The high plateau itself is remarkably fertile, and only lacks irrigation. There is no reason why the fine wool industry should not be considerably extended and organized. The main cordilleras are one huge minefield awaiting cheap transport for freer development. They have only been picked at here and there. Gold, silver, tin, copper, bismuth, and precious stones have been extracted from them, with very superficial prospecting. Across the mountains are the fertile valleys of the Yungas, Challana, and many more, well watered and well wooded—almost every stream giving colours to the gold prospector. There is the virgin region of the Caupolican, almost of a certainty rich in minerals.

Bordering the valleys to the east are grass plains, which only lack easy communication for an extensive cattle industry—also the region of coal and petroleum, both in quantity. On the Altiplanicie and Pacific coast generally there are constantly increasing demands for food, fuel, and building materials, all lying in abundance a few miles over the mountains, and at present imported. Rubber in the higher lands east of the Andes is not a commercially good enterprise, except with abnormal prices, for the trees are comparatively few and give little latex.

The forests which extend from the Andes to the Atlantic abound in valuable timber, walnut, cedar and hard woods, and the soil is prolific. In the basin of the Amazon, from about 800 feet above the sea down, rubber is exceedingly rich. In places one man can gather two tons a year. Caouchouc is plentiful up to 1500 feet. The Peruvians concern themselves with this product, the extraction of which involves the destruction of the trees.

The duration of the rubber industry in Brazil and Bolivia is a matter of great interest and diversity of opinion. The areas most prolific in rubber trees are already exploited, but there are yet vast untouched areas where the trees are not so numerous or generous of latex. In certain places reckless gathering has destroyed the trees. In others, possibly owing to the seed falling from trees which have been assiduously tapped, the young trees are weak, and either fall a ready prey to insects or, reaching a growth of some 6 feet, wither away. There is very little planting attempted.

To the south and west of the rubber districts lie the great plains of Mojos rich in iron ore. Over these plains still range herds of wild

cattle. So savage are they that to traverse the plains on foot is a most perilous matter.

With the headwaters of the Guapore and its tributaries terminate the Amazonian forests. The schist, granite, and sandstone masses of the Ricardo Franco, Parecis, and Aguapeh hills form the watershed of the Amazonian and Paraguayan basins. To the south stretch the flat plains of the Paraguay, punctuated by short ridges and conical hills of limestone and ironstone rich in manganese—a patchwork of scrub, forest, swamp, and grass plains. From here south, where the annual inundations permit, the country is occupied by small squatters trading in the Paraguay, with a commercial centre at Corumba. Near the old city of Matto Grosso the scrub forests, rich in cotton trees, clothe themselves in wonderful beauty in the early spring; a few bright greens and elegant palms, and for the rest a riot of flowers, blue, yellow, purple, and red—gorgeous and prodigious natural bouquets.

Corumba is a centre of considerable trade. I have heard the Paraguay river termed a disappointing waterway. Yet between Buenos Aires and Corumba there is all the year round navigation for steamers drawing 7 feet of water, and from December to June considerably more. Between Corumba, Cuyaba, and St. Luiz de Caceres there is always navigation for launches drawing 3 feet. Corumba is being linked to the Atlantic by railway, which will do much for this region, as also Eastern Bolivia. The section from the Parana to Miranda will be completed this year.

For Bolivia the great difficulty is its scanty population, and its inability hitherto to attract immigration. So much so is this the case that in the north-eastern regions east of the Cordilleras riches are measured by the number of men at the command of an individual. A man with fifty peons is a capitalist. The greatest rubber concern in the Beni, with three thousand peons, is practically a state. So much for the general features of the country.

There is talk of more attention to South American exploration, and as, even in the continent itself, it is extremely difficult to obtain any reliable idea of the conditions it is necessary to contend with—chiefly perhaps because explorers outside more or less civilized regions do not exist—I am going to give a short impression.

The upper waters of the Andean rivers are mountain torrents which cut a roaring and resistless passage through their valleys of slate, gneiss, and sandstone. If the long tiring mule journeys to the south are to be avoided, it is necessary to descend these torrents on a raft, called a "callapo," managed by five or six Indians. It is sufficiently perilous to please any one. When the rivers become clear of rapids, navigation is continued in open boats of an awkward model, known as "batelones," paddled by a dozen to twenty Indians or mestizos. In the area of rubber estates there are river launches.

The currents of these rivers vary from 3 to 6 miles an hour, and their courses are obstructed by snags so numerous as to be a constant menace to navigation. The result is frequent shipwreck. Now, once wrecked there are other unpleasant possibilities besides getting wet. In the Amazonian rivers there are anacondas, crocodiles, electric eels, sting rays, and the perania, a small deep-bodied fish with razor-like teeth and an unappeasable appetite for blood. This last is more numerous in the river Paraguay, where men who are unfortunate enough to fall into the river may be picked clean before they can be rescued.

In the river Paraguay and its tributaries is also to be found the "mungruyu," locally known as the fresh-water shark, probably a variety of the Brazilian arapaima, and reputed to consider any luckless human being as an article of diet.

The consequence of these presences is a high percentage of mortality, notwithstanding that the Indian is a splendid swimmer. Men bathing not infrequently disappear. When I was returning from Riberalta to La Paz *viâ* the Beni at the end of 1907, we were wrecked three times—once on a sandbank where the boat turned turtle, and twice on snags. The second time I had an Indian seated upon a hole about the size of his head for two hours to keep the boat from foundering. One perforce gets accustomed to such accidents after a time, and trusts that they will occur in convenient places. It is said in the lower Beni that 25 per cent. of the crews of the river boats perish annually of accidents and fever. The food question is a serious one. Starvation has been the great difficulty in South American exploration from the days of Pizarro, whenever any considerable force has been employed.

Rubber baraccas and small estancias exist at intervals on the main rivers, where rice and chaki or dried meat are obtainable; and at a centre, for instance, like Riberalta a few preserves can be purchased at a price 1000 per cent. over those familiar outside. Game is nowhere plentiful in South America. There is usually sufficient to feed a small party, but never a large one. But it is rarely advisable to separate a party in order to hunt for game, owing to the savages and the danger of getting bushed. About six years ago a French firm in the Beni sent an expedition of twenty-three men into the upper Madre de Dios to look for rubber. Of the party only three returned, the remainder died of starvation or its effects.

The jaguar is common enough, particularly in cattle districts. He is usually cowardly, but in places is a man-eater. There are two varieties, one the size of a big leopard, the other somewhat larger than a Bengal tiger. In the cattle districts of Mojos and the Paraguay, it is a common sport amongst the Gauchos to lasso these beasts. The black panther is, however, universally dreaded. He is rare, and I have only seen one skin. The anaconda is ubiquitous, and haunts rivers, swamps, and lagoons. It moves by night, and has a weird cry. The rattlesnake,

SORATA.

LA PAZ.

COBIJA OR BAHIA.

VIEW FROM COBIJA, RIVER ACRE.

or cascabella, and other species of poisonous snakes are about as abundant as such reptiles are in India, but are rarely met with in the dry season.

Insects are legion. They are the pest of South American travel. Mosquitoes of course; roca-roca, a microscopic fly which at times makes observation work by night almost impossible; marigwis, or the Portuguese pium, which in the dry season attacks in thousands, every one leaving its small blood-blister; "gehene," a microscopic night fly which penetrates any mosquito net; tavenas, or a species of poisonous housefly; wasps and bees of all sizes. Bees do not suggest any serious discomfort. Yet in places one is covered from head to foot by them, inside one's clothes and outside, in one's ears, nose, eyes, hair, and mouth if it is opened, pungent odoured and seeking salt perspiration. Feeding by day under such circumstances is out of the question. If I could describe the misery born sometimes of these flying and crawling pests, it would be thought a traveller's tale. There is only one remedy—custom. There are moths and flies which lay eggs in the head or under the skin, ripening painfully to maggots. There are jiggers for the toes; ticks in myriads; guanacos, a small white insect something like a tick, only with an infinitely more irritating bite; microscopic ticks, known as the "haputama," or "bichu colorado," which burrow and die under the skin; venomous giant spiders, known as "apazancas;" vampire bats and ants.

The latter are a perpetual worry in the forest. The worst are the small red species which colonize the "palos santos," or sacred trees, and whose bite is worse than a wasp-sting. The savages have an unpleasant custom of binding captives to these trees, which involves a painful death in about two hours. There are the tucandera, or black ants, about an inch in length, which live six or seven together in trees. Their bite is agonizing. Mr. Fisher, my assistant since 1908, was a victim. In Indians or South Americans it usually induces a high fever. One can almost generalize and say that every insect bites or stings or annoys in some manner. There is a species of ant with formidable mandibles known as the "sepi," which attacks by night. I was reduced to rags by an experience of this sort in the Verde.

I do not mean to suggest that this tale of insects is to be found everywhere. It is in any case confined for the greater part to the forest regions and plains under 1000 feet above sea-level. Moreover, they have their seasons and localities of special activity. Mosquitoes are ubiquitous, and worse in the rivers than in the forest. They are particularly voracious in the wet season. There is a white variety in Lake Caceres, near Corumba, which are most venomous, and in the Acre a mammoth about an inch in length about whose character local rumour has been busy. The "pium" is at its worst in the Orton and Madre de Dios; ticks and "guanacos" in northern Matto Grosso in the dry season. The "Palos santos" ant haunts the margin of rivers, and

is most active in the Abuna, where small areas of forest are to be found consisting wholly of these trees impassable alike by man and beast. The "tucandera" and "sepi" prefer dry country. Bees favour dry cotton-wood forest, such as in northern Matto Grosso, where rotten trees and plentiful flowers suit their peculiar needs. "Tavenas" and wasps are more active in the Acre. Insect life is, however, a curse to low-country exploration. One is scratching or slapping every waking moment.

In villages and baraccas palliation can be obtained by clearing and cleanliness; and the "pium" will not enter a darkened house. Scratching is commonly reputed to be the cause of "espundia," a very common ulcerous sore most difficult to heal; and the virus of this sore may be carried to the nose, in which case the cartilage sloughs away. All the fevers to which the tropics are heir may be met in the forest, and other grievous disorders more or less obscure, such as beri-beri, espundia, and "corupcion." Most of these are fortunately confined to areas of population, where they are encouraged by bad food and complete absence of sanitation. Imagine chaki from which the maggots have to be shaken, and rice which has to be washed again and again before it is fit to eat. Yet in the rubber zone, where communication is precarious and there is practically no game, one may be glad to get even this. Fortunately, except in the towns of the higher country, typhoid and dysentery are unknown.

The vegetation of the forest itself needs care. The Brazil nut tree, prolific in the Amazonas, sheds its heavy nuts in December and January from a height of 100 to 150 feet. Broken heads and bones are not uncommon. There is, too, a species of tree met with in the poorer forest on the higher ground near the sources of rivers, paralleled, I am told, in Central America. A colourless liquid drops from its leaves, which causes the body to swell, accompanied by great pain. Clothes, doubtless, are a protection. I had an Indian peon so affected in the Verde, who was familiar with the cause, but we neither identified the tree nor experimented.

The climate itself is not that of Eastern tropics. It is subject to remarkable changes. I have known the temperature drop in Riberalta from 104° Fahr. to 44° in two hours, and the 44° was bitterly cold. During this last year, in August, it fell from 78° overnight to 41° in the early morning. These falls are known as "surasus," or south winds. They last usually two to four days, with much rain, and are common from May to October.

Away from civilization transport is a serious problem. So long as a party is content to navigate a river or proceed by water there is no great difficulty. But river exploration is no longer so necessary. By land the forest must be cut through. In the Verde we progressed through cane brakes and thorny undergrowth about half a mile a day at times.

Mules, which are the best animals for transport, break down on rocky ground from sore feet, are most dependent on good supplies of water, and not very easy to feed over a long period in the forest. In desert country, such for instance as is reported to exist north-east of the Parecis hills in Malto Grosso, or in country cut up by difficult gorges, animal transport must be dispensed with. Heavily loaded, their backs cut up, and are immediately attacked by insects. Any expedition must be prepared to carry its equipment and supplies on the backs of its members.

Added to these disabilities is the difficulty of securing peons. Labour being scarce is very carefully preserved. In Eastern Bolivia it is Indian and Mestizo. Both are unreliable, difficult to please, lazy, and desert without notice. Usually they are unobtainable at any price. Inexperienced white men are more reliable, but of doubtful value. They are only too easily lost in the forest, once out of sight of camp or river, and if they cannot hunt it is difficult to feed them when supplies run short. It is therefore evident that three qualifications are very necessary for South American exploration—a strong constitution, determination, and experience. I am not exaggerating when I say that scores of expeditions into the unknown regions of South America have either been lost, decimated, or rendered abortive for the lack of one or the other of these three qualifications. I only know of three men who have succeeded; one is a Peruvian gentleman and resident in the Acre, who lived for two years with the savages of the Putumayo. His diet was Indian, which he told me was very good, once over the prejudice; but drawing the line at white man, he was forced to escape. The second is General Pando, who, with the loss of four or five, took fifteen men across the Caupolican from the Heath to Ixiamas. The third is Major Rondon, who, with an army of five hundred Brazilian soldiers, is constructing a telegraph line from Cuyaba to the falls of the Madera, and his losses in officers and men have been tremendous, notwithstanding a scientific staff and unlimited resources at his disposal. The foreign naturalists who assert that they have lived with the wild Indians draw upon their imaginations. I have met some of these people.

In Bolivia there does not remain much unexplored country, although a considerable area requires proper mapping. The northern portion of the Caupolican lying to the south-east of the old Peruvian province of Carabaya, and including the river Heath, comes within the operations of my party this year. In the west of the Caupolican were the old missions of Apolobamba, and there are said to be Incan remains; but the wild Guarayo Indians of the Caupolican have never been tamed or brought within the influence of any civilization. The river Heath is completely unknown from a few miles above its confluence with the Madre de Dias. It now forms part of the new frontier with Peru.

In Brazil and eastern Peru well clear of the Cordilleras there is

an immense area of unexplored country. As I have said before, outside of the rubber industry, and even to a certain extent within it, nothing is known of the country or its inhabitants 100 yards from the river-banks. There is ample scope for adventurous explorers in the geography, ethnology, fauna, and flora of these obscure regions; but it is work which permits of no luxury of food or equipment. The story of Hernandez Pizarro and his trying march from Quito to the Amazon has to be repeated if any considerable force be taken. It may reasonably have the same quest, for ever since that notable pursuit of an elusive Indian civilization, there have been rumours in the interior of South America of the existence of a strange tribe. The evidence is necessarily weak. Yet I have met half a dozen men who swear to a glimpse of white Indians with red hair. Such communication as there has been in certain parts with the wild Indians asserts the existence of such a race with blue eyes. Plenty of people have heard of them in the interior. They even have a name—the "Morcegos," or bats—the people who travel and hunt by night and hide by day. Some of my informants I have known well, and I believe there may be some foundation for the story. They would appear to be nomadic. We know little or nothing about the interior, and the wild tribes do not live on the river-banks. Even in easily reached Paraguay I am told there is a tribe so shy as to be quite outside of communication, and another whose men talk one language and its women another. These things are not generally known, and yet it is safer to travel in Paraguay than in Eastern Europe. There may be many curious things hidden in the forests of the Amazon basin. There are rumours of old ruins and strange animals—of tracks huge and unrecognized. Fables gather, of course, around unexplored places, but we must not forget that the African pigmy and the okapi were for long discredited. The exploration which commences this year may have interesting results.

Bolivia has suffered, as all countries improperly organized for war always do suffer in the end, from continual loss of territory. In 1902 occurred the revolution in the Acre, on the face of it the resentment of a Brazilian population against the misrule of ill-chosen Bolivian officials, and engineered as these events usually are from the outside. Bolivia, tied to long and difficult communications, could do nothing. Such troops as could be transported to the Acre fought splendidly—for the Bolivian soldier is hard to beat. Ultimately there evolved the Treaty of Petropolis, whereby Bolivia ceded some 70,000 square kilometres of the Acre to Brazil in return for £2,000,000 and certain territorial concessions giving access to navigable waters in the river Paraguay. A new frontier-line was based upon such geographical details as were known or could be surmised, and this is how, in 1906, I became connected with the work at the kindly suggestion of my friend Dr. Keltie.

UPPER VERDE.

SANDSTONE CANON IN RIO VERDE.

CONFLUENCE OF THE MADRE DE DIOS AND BENE.

XAPURY ON THE ACRE.

My experiences commenced in 1906 with a descent of the Beni to Riberalta, a journey which has been described to the Society by Prof. Evans. From here, with Mr. A. J. Chivers as assistant, a young Bolivian, Señor Carlos Dun, and eight Indians found for me by General Pando, I spent a month and a half ascending the river Orton to Porvenir, whence we passed by land to Bahia, or as it is now called Cobija, in the Acre, a point on the frontier important to Bolivia by reason of its direct communication with the ocean. Here we tracked up the Arroyo Bahia, and subsequently spent three months ascending the Acre to a point adjacent to its source in order to discover its relation to parallel 11° S.

Parrots, dense forest, and half a mile of coffee-coloured river cutting a sinuous course in red lacustrine deposit is the tale of months—never the sign of a hill—weeks of laborious dragging of heavy canoes over sharp sandstone rocks—constant vigilance, heavy rains, and not too much food—a story of much small incident and very hard work.

From the Acre we crossed to the Abuna, exploring *en route* the headwaters of the Rapirran and Iquiry in dense forest. From this point Mr. Chivers left for home sick, followed by five of my Indians, rendered useless by fever. I had perforce to descend the Abuna in a small boat with Señor Carlos Dun and three Indians, running the gauntlet of Brazilian outlaws and the Pacaguara savages which infest the lower river.

The Abuna is probably the most unhealthy river in the Amazonas. No one can live on its banks for long. Some six years ago an expedition of two hundred peons explored the Rio Blanco, a tributary, for rubber. All but seven died. In the baracca of Sta. Rosa where we struck the river there were three deaths a week. It was in this river that we killed a huge anaconda, whose dimensions have, I observe, aroused scepticism in some quarters. It was coiled around a trunk and partly out of the water. The Indians were most anxious that we should not shoot, as these reptiles are said to attack small boats if irritated. It measured approximately 48 feet out of the water, and we estimated another 17 feet in—far too colossal a reptile to skin even could we have carried or preserved such a thing, or the Indians had been willing to operate. That it was an uncommon size is probable—that it is exceptional, I doubt; for the tracks of these reptiles from the swamps whence they emerge by night suggest a prodigious size. The Brazilian Boundary Commission in Corumba told me of one killed near that town measuring 85 feet.

Two of my Indians died on my return to the Beni; and Señor Dun has died since. He was an enthusiastic and most plucky companion, who might easily have left his mark on the country. I reached Riberalta in April, and La Paz in November, after two and a half months of most trying journey.

The results of the exploration bring the line of the River Acre, west of Cobija, into the frontier from that village to the confluence of the Yaverija, where enters the new frontier with Peru. Between Cobija and the Abuna, however, there is needed a modification of the line proposed. For the treaty of Petropolis agreed provisionally upon a line due west from lat. 10° 20′ in the Abuna to meet the river Rapirran, at that time supposed to be an affluent of the Ituxy, the ascent of the Rapirran to its source, and a line due west from that point to meet the Iquiry, whence it was to ascend that river and pass by the most defined watershed to the source of the Arroyo Bahia, descending this stream to meet the Acre at Cobija. The Rapirran, however, flows north of 10° 20′ S., and bends round to enter the Abuna in lat. 10° 20′ 15″. The Iquiry, moreover, rises and flows considerably to the north of the source of the Rapirran, whilst in the forest the accidents of the land-surface are for practical purposes unrecognizable. The probable modification is a line from the source of the Rapirran to the confluence of the Arroyo Bahia, or possibly the course of the Abuna and its affluent the Ina, and from the source of the latter a short line to the confluence of the Arroyo Bahia. The trouble is to agree upon a modification in rich rubber forest carrying customs duties. No watershed is easily recognizable in the forest of this region. However, it is a matter for the Congresses of both countries.

On returning to La Paz, I undertook, at the request of the Government, the delimitation of the eastern frontier, where an international commission had from one cause and another been delaying its operations for two years. In May, 1908, therefore, I was in Corumba with a French engineer, Mons. Vaudry, and Mr. F. G. Fisher as assistants. I had a staff, and also a French cook; the cook in fact of the Russian admiral of North Sea fishing-fleet notoriety. This luxury I may say at once was confined to Corumba. The work consisted in a rearrangement of the frontier in the neighbourhood of Corumba, bringing Bolivia into navigable waters; a modification of the frontier in the lakes of Caceres, Mandiore, and Gaiba; and a settlement of a disputed question over the river Verde, an affluent of the Guapore in Northern Matto Grosso.

The geodetical work in the neighbourhood of Corumba was completed in two months, a rapidity which was far from pleasing to our Brazilian colleagues. Beyond a little work in the lakes, there was practically nothing more to do, and the river was too high to permit of the former being completed until September. I, therefore, urged upon the Brazilian Commissioner the opportunity of exploring the Verde. This he declined to do on the justifiable grounds that it required more organization.

Various arguments had been put forward regarding this river: that the Turvo, where the old boundary mark had been located, was

in reality the Verde; that it had been at any rate accepted as the Verde; that it was an old boundary mark of Portuguese dominion; that the river Verde had changed its course, and so forth. In the interests of Bolivia, therefore, I left my competent French colleague in charge of the lake work, and with Mr. Fisher, an English settler named Urquhart, and six peons, set out for the Verde. It was, perhaps, a heinous precedent in international boundary work, and I risked trouble in the event of failure.

This river had given rise to considerable discussion. An international commission of 1878, which delimited the eastern frontier, had passed its confluence with the Guapore in lat. 14° S., and ascending the latter river to the old city of Matto Grosso, had from a high point in the Ricardo Franco hills descried to the south-west a small stream, which they forthwith assumed to be the headwaters of the Verde. They reported the Ricardo Franco hills as impassable, owing to the terrific gorges which cut up its sandstone formation. This report also mentions that two other Brazilian parties failed to enter these hills for the same reason. Later the rubber explorers of the river Paragua further west reported the Turvo as being an affluent of that river.

Old Matto Grosso city, located on a low site on the right bank of the Guapore in lat. 15° S., was the capital of Matto Grosso state, and is said to have had a population of 40,000 Portuguese and slaves in the eighteenth century, principally engaged in gold-washing in the Parecis hills. The decay of this industry, its extreme unhealthiness, and constant trouble with the savages, led to its abandonment in favour of Cuyaba. It suffers to this day from the prevalence of a horrible disease known as "corupcion," which is reputed to kill 80 per cent. of those who merely pass through in the wet season. It has a present population of about a hundred negroes, whom the Parecis and Cabecis savages, who infest the surrounding country, have sworn to exterminate. There is, in fact, a constant war of reprisals. The houses, or propped up mud ruins, are barricaded every night, when savages frequently prowl the streets. It is risky to leave the village alone by day or unarmed under any circumstances.

The Guapore takes its rise in the hills of the Parecis, exactly where is not known, and flowing south to the latitude of Matto Grosso, sweeps round to that city, joined by the Alegre and Barbados rivers a short distance above.

Two leagues west of the city the hills of Ricardo Franco rise abruptly from the forest plains to a height of over 3000 feet, crowned by formidable precipices. Of the interior of these hills nothing was known. They were believed to be inhabited by the Parecis savages. A Bolivian commission to the Turvo in 1906 abandoned the ascent of the hills as too difficult. In 1904 or 1905 a rubber owner in the Paragua attempted to cut into the hills with a large force and failed.

Several private rubber exploring expeditions ascended the Verde from its confluence up to some 20 miles and returned owing to the difficulties and trouble with the savages. The latter had destroyed the old boundary marks at the confluence. A Bolivian, one Antonio Landivar, operated a rubber estate near the confluence for a short time, but was forced to abandon it owing to perpetual attacks by the savages. It may be realized, therefore, that an exploration needed some consideration. From Corumba to the old city of Matto Grosso we were warned not to venture, and were considered mad.

For peons I had two Indians from Chiquitos, an Argentine waiter, a Paraguayan silversmith, and a Spanish baker and tailor, the last four of whom had never held a rifle. They were the only men I could tempt to face the Guapore. For transport I had to chance picking up animals on credit, as the political commissioner, General Pando, was still in Buenos Aires, and I could only raise £200 for a journey in a country where money vanishes like mist under a morning sun.

We availed ourselves of a passing launch to Descalvados, a Belgian cattle station, and thence passed some 250 miles overland to Matto Grosso city. Here I exchanged such animals as I had been able to pick up for two small boats, descended the Guapore to the confluence of the Verde, proved the position of that point, in whose latitude I differ from that determined by the Commission of 1878 by some 10″, and then commenced the ascent of the Verde. On the second day we were obliged to abandon the boats owing to the impossibility of dragging them through the rapids, sinking them in the river, and burying all the surplus stores, together with money and various instruments, against our return. On the following day we had to again reduce loads of blankets and the entire food supply, owing to the exhaustion of the peons and the difficulty of getting through dense undergrowth, or climbing over the *débris* and boulders which obstruct the canyon in which the river flows.

We were now limited to hammocks, rifles, ammunition, camera, and instruments, which were distributed over the entire party. The river up to this point had been prolific in fish, and, as I have already said, one can usually depend upon the forest to provide for a small party. I will spare excessive detail of our sufferings. Shortly afterwards the water became strongly impregnated with iron, and bitter to the taste; fish gave out in the river; and game deserted the locality. For nearly three weeks we lived upon occasional palm tops; were eaten up by insects; were drenched by a succession of violent storms with a southerly wind, bitterly cold for wet and blanketless people; were sometimes climbing all day over boulders, and at other times crawling perhaps half a mile a day through dense cane and thorny undergrowth. With the perpetual damp our boots came to pieces. Two out of four dogs died. We emerged at last with fine weather on to open country near the source of the river, congratulating ourselves that we were through. In view of

RIVER TAHUAMANY AT PORVENIR.

AREQUIPA.

CORUMBA.

VIEW FROM CORUMBA WEST.

The Fellows' R.G.S. Antarctic Fund

The following Subscriptions to the Fellows' Royal Geographical Society Antarctic Fund, in aid of Captain Scott's Expedition, amounting to £976 5*s.* 6*d.*, have been received up to the 20th April :—

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Any further subscriptions will be acknowledged separately as they are made, but in the June issue of the Journal a statement will be inserted showing the total amount raised, the number of subscribers, the expenses incurred for printing and postage, and the balance which was paid to Captain Scott in aid of his Expedition.

The Fund will be closed before the departure of the Expedition on the 1st June.

the state of the party, I abandoned the idea of returning by the river. Moreover, chronometer watches were useless, and longitude could only be obtained by carrying it by latitude and azimuth observations and triangulation through the hills to Matto Grosso. It looked simple enough. Instead of three days, however, we occupied three more weeks. Palms were scarce in the open country, but their place was taken by occasional finds of a very hard and tasteless nut, known as "chunta." The two remaining dogs died. We all, curiously enough, grew deaf for want of food. The peons prayed to be allowed to die, and had to be beaten to make them go on. Day after day we came suddenly upon deep gorges, necessitating long *détours*. The very accidented plateau of the Ricardo Franco is covered by long coarse matted grass, beneath which and out of sight the surface is strewn with sharp boulders, over which we were constantly falling. A tree fell on Urquhart's leg, necessitating a distribution of his load, and Mr. Fisher was bitten by a tucandera. A hot vertical sun did not improve matters, and insects were awful. At the southern end of the hills I shot a deer. It was at very long range for a Winchester carbine, and an absolute fluke; but it saved us, or some of us anyway. It was the only live thing which we saw in the hills, excepting some partridges, which we could not kill. Of savages we saw none. We frequently crossed their tracks, and every night on the open country saw distant fires. A watch was kept every night, or rather supposed to be kept, for I fancy it was observed mostly in the breach. If there were any, they left us alone, as they had previously done in the Acre. We had, however, the constant anxiety of expecting trouble with them.

A few days later we got down with difficulty to the forest, where three black monkeys walked into camp. They disappeared entirely in ten minutes, the peons consuming the skins, fur and all. We also struck three nests of honey. The first was strong and made us all drunk; and the third was vinegary, and left the peons, who alone had no prejudices, in convulsions. We reached Matto Grosso after a week of forest cutting on October 19, and promptly made ourselves sick on coarse sugar, which of all things we had missed most. We were of course extremely thin, which may be better appreciated in the lantern slide, which shows the party after one month of restricted diet. I do not think that the starvation did us much harm. The danger lay in the return to the disease-stricken Matto Grosso in a weak state. Five of the six peons died of the results. I met the survivor this year, a fellow-prisoner amongst the revolutionaries in Northern Paraguay, and he told me of their fate. On November 18 we reached Corumba, where we were warmly welcomed by General Pando and the remainder of the Commission. The result of this exploration has been of great importance to Bolivia. It effectually disposed of all theories regarding the Verde; brought back information of high and valuable country; and made

certain a joint delimitation of the river. In fact this last year the delimitation was carried out.

Such, however, is the honour of the prophet in his own country that our Brazilian friends were inclined to look upon our reports as travellers' exaggeration. They had our maps and reports, and were fully prepared regardless of expense. The latter, however, is not much use in places where everything depends upon questions of transport. One party accompanied me across the Ricardo Franco hills with ladened animals, a journey which, thanks only to the 1908 experiences, was rendered possible.

Another descended the Guapore to follow our route of the previous year and ascend the Verde, carrying everything in shoulder-packs. The engineer of this party had the bad luck to fall badly off the rocks into the river, and was forced to return sick to Matto Grosso with his instruments, leaving a lightly equipped force to follow the river. The engineer who accompanied me arrived sick at the source after eighteen days of certainly trying journey in the hills. In order to carry more food, he had depended for instruments upon the river party. That the northern party, in spite of its information and preparations and absence of instruments, occupied nearly eight weeks before its return to Matto Grosso in perfect weather and with a well-marked route opened from the source of the Verde across the hills, suggests that it had a pretty hard time. I have not heard any details, as we had left Corumba before its return there. The net result is that the work of the Bolivian Commission holds good as the work of the joint commission, and that two years sufficed to complete work for which seven had been anticipated. I more than willingly pay a tribute to the courtesy, competence, and geniality of my Brazilian colleagues. A better lot of fellows it would be hard to find. But they were not young, and it is not given to every one to successfully withstand the trials of pioneering.

Of our boats and buried effects the engineer of the northern Brazilian party encountered only one boat, upside down and high up in the forest on the bank of the river below. The other and all our goods had been washed away. I did, however, meet a story down south of £37,000 in gold buried in the Verde by the Bolivian Commission. Future treasure-seekers may be interested to know that it in reality amounted to £37. I apologize that the account is of necessity cursory; nor does it embrace the thousand and one adventures which are inevitable in such work.

I should like to record my appreciation of the companionship of Mr. F. G. Fisher, who accompanied me in these journeys of the last two years. In such exploration a congenial companion who can take his share of the work and is imbued with that enthusiasm for results which places loyalty before thoughts of personal risk is not so easily to be

found. I should also like to say that the interior of South America calls aloud for scientific exploration.

And when I say "the interior" I do not mean pottering about the Andean slopes, where a debased type of savage is sufficiently tame to have adopted some of the vices of civilization, or the more or less comfortable navigation of rivers, but thorough exploration of those forest regions in the heart of the continent which are still marked "unexplored." The difficulties I have sketched refer to such parts, and here also lies the solution of interesting problems. The old recognized transcontinental highways of trade can be traversed with certain discomfort, and incidents possibly interesting but utterly barren of important result.

It is my regret that difficulties with peons and their hopeless cowardice has prevented me doing more, such, for instance, as returning, as I wished to do this past year, from the source of the Verde by the Parecis hills due east.

It is singular that this continent has been so long neglected, unless exploration is, as some one has suggested, a matter of fashion. Here, however, in these days of luxurious equipment and perfection of organization, the explorer of unmapped corners must return to pioneer methods, and be content with his hammock and his rifle and what a kindly Providence will send him for food. I hope it will be for Englishmen, the race after all most appreciated in South America, to follow their traditions and show the way.

The PRESIDENT (before the paper): Major Fawcett, the lecturer for to-night, was an officer of the R.A., who, both during his service in the army and since his retirement, has done excellent work in surveying. His first expedition was to Morocco in the year 1902, and some account of his expeditions appeared in our *Journal*. But his most important exploratory work was his last expedition, which he is going to describe to-night, an expedition in which he undertook the delimitation of the boundary between Bolivia and Brazil on behalf of the Bolivian Government. Certain short accounts of this work have appeared from time to time in our *Journal*, but I think to-night's paper is the first complete history of his exploration which has yet been given to us. As a Society, we are proud of Major Fawcett, for he went through the course of instruction in surveying at Savile Row, and took our Diploma. We may therefore, I think, look upon him not only as a distinguished explorer, but as one of our pupils.

Colonel PEDRO SUAREZ: In the first place, allow me to thank Dr. Keltie for having recommended Major Fawcett to me in 1906, as he has done a large amount of useful work for Bolivia, and he has done it in such a manner that it has not only been accepted by my Government, but also by the Brazilian Government, which says a great deal in his favour. Major Fawcett has told you a great deal about the wild animals and insects he has met with during his explorations in some of the more outlandish places he has passed through, but I can assure you that the towns are not so bad as you may imagine from what he has said. It is quite true that there is a great number of insects and wild animals, but in regard to the savages, they are greatly reduced in number now. With regard to the question of food

supplies, I may say that my Government has always provided plenty of provisions for the different expeditions, and on the last occasion I doubled the list of provisions that Major Fawcett and Mr. Fisher requested me to order for them. The difficulty has been in obtaining sufficient animals to transport goods for the very long journey they had to undertake, and the proof that they had a sufficient supply of food is, that when they returned to Matto Grosso they presented the Brazilian Commission with what remained. As Major Fawcett has informed you, undoubtedly Bolivia is the land of the future, as it is progressing rapidly with the new railways that are now under construction, with English capital. My Government is so well satisfied with the work performed by Major Fawcett and Mr. Fisher, that I have been instructed to engage two more English officers and six non-commissioned officers for the frontier work. I am sorry not to see here to-night the old familiar face of the late Colonel Church, who took such an interest in all the Latin American countries, and who knew more about Bolivia than any Bolivian, but I am pleased to see here some others who have been there; for example, Sir Martin Conway, who has climbed the highest mountain, and who can undoubtedly tell you something about La Paz and other towns in Bolivia. I must conclude now by thanking Major Fawcett for the interesting paper he has read about my country.

Sir Martin Conway: I am thankful to say I have not been in the parts of Bolivia described here to-night. I think it is not difficult for us now to explain how it comes about that the forest region of the Amazon should be the last portion of the world remaining to be explored. You must be careful not to conclude that all Bolivia is a land of this description, as it were a portion of the Tertiary world surviving into our own day. These gigantic reptiles, all this strange life, of which we have been told, seem to belong to a past geological period. The unknown has an immense attraction for every one, and especially for adventurous souls, so that perhaps what we have heard, for all its horrors, may act as a kind of challenge to some to go forth and discover. Certainly, for the naturalist this region must be intensely interesting. I prefer the higher lands. Bolivia possesses the remarkable quality that it contains regions of almost every kind. There is, I think, no country in the world where you have, within a territory only five times as big as the United Kingdom, not only this remarkable rich forest district, low-lying, tropical, and, almost within view of it, mountains, 21,000 and 22,000 feet in height, covered with great glaciers and perpetual snow; but besides snow-mountains and tropical forests Bolivia has regions of utter desert, and out of them strange volcanic, extinct volcanic, mountains rise, their flanks displaying all kinds of coloured rocks, and around their bases great dried-up lakes, now represented by expanses of white salts spread abroad over vast areas. All this part of the country resembles a portion of the surface of the moon. In Bolivia you have also fertile regions something like the Italian lakes or the West Indies, rich beautiful regions filling the belt between the high snows and the forest swamps. This is a region of undulating hills, fertile, beautiful in form, a region as fair, as lovely, as any on the face of the Earth. Well, you may imagine that in a country like this, so varied in its surface and so enormously rich in its undeveloped resources, a country, moreover, inhabited by a brave people—a people (I refer not, of course, to the forest folk, of whom we should like to hear a great deal more, but I refer to the population of the higher regions) in whose veins flows the blood of the best families of Andalusia and of the governing caste of the Incas. They are, moreover, an imaginative race also, and intellectually well endowed, for whom a great future undoubtedly waits. About such a country and such a people, it is, I think, quite certain that there will be a story hereafter to tell.

Mr. W. S. Barclay: Major Fawcett's lecture referred to the extraordinary progress that has been made in South America during the last decade. There are certain things that we all recognize, and that is one of them. South America is furnishing to-day a very large proportion of the foodstuffs and raw materials which we require in Europe. Argentina exports more cereals than Canada. Three-quarters of the world's coffee and half of the world's rubber still comes from Brazil. We have heard of the depletion of forests. The largest, densest, and most valuable forests in the world cover over a million square miles in the Amazon and Alto Parana basins. Meanwhile, South America manufactures very little. I know of no instance so striking as the town of Buenos Aires, which, apart from foodstuffs, practically lives on imports. This is also largely the case in Peru, Brazil, and Bolivia. Countries in these conditions, supplying food and raw materials, and absorbing manufactures, are bound to receive great attention from European nations.

On the North American continent settlement began on the Atlantic coast, and it spread west to the Pacific, across the inland plains and over the Rockies. In South America the nations early planted themselves on both coasts. Thus, while in North America the trend of railways and lines of communication has been from east to west, in South America the tendency has been from either coast inland. That tendency, due to competition among nations occupying the coast-line, has been very much hastened of late years. Four lines are to-day converging towards the region which Major Fawcett has shown us to-night. In the south railroads are stretching up from Argentina. Within twelve months we shall have through rail communication between Ascension and Buenos Aires. In the north the most important strategical line on the South American continent, the Madeira-Mamore railway, will be completed within three years. This line will handle the traffic between the upper and lower Amazon basins. From the east comes the Saõ Paulo-Corumbá line, across Brazil. Already they are building a bridge over the Alto Paraná river, while the Corumbá section has been completed and will be opened next September. And westward, Major Fawcett has told us that a railway connecting the plateaux to the lowlands of Bolivia is almost inevitable.

Thus we see four lines all converging upon this district, the very heart of South America. The methods by which they advance are perhaps not all that geographers could wish. The gentlemen who build them might with advantage study more of the country before they start construction. When Colonel Church projected the building of the Madeira Falls railway, he roughly surveyed the whole of the upper basin of the Madeira, as far as its water-parting with the Paraguay river. As a consequence his deductions, made forty years ago, still hold good to-day. I would ask any one familiar with railway enterprise in South America to say if it is not true that millions of money have been wasted for want of adequate survey and mapping beforehand, of which the total cost would have been very small, and the benefits incalculable. I would suggest that the board of every South American railway make it a *sine quâ non* that their general managers on the spot should also be Fellows of the Royal Geographical Society.

When one talks of lines of communication, the problem bound up with it is the development of the country. It is no good building a railway if you have got nothing to haul on it. In colonizing these hinterlands it is best to tackle the open prairie before the forest country, and anybody who settles in pampa land ought to take with him as many cattle as he can and a box of matches. By burning the long grass and rushes constantly an enormous number of insect pests are destroyed, while the cattle-tracks form little paths which help swamp-water to drain off.

One final point. Most of the transport lines in South America are altogether too modest. They hide their lights under a bushel. Not only do they descry all knowledge of each other's time-tables; they do not appear to know that any competing line even exists. Now, it does not cost very much to get up a little book to tell about yourself to interested people; it is not much trouble, if you have drawn a map, to send it to the Royal Geographical Society. But South American railway, telegraph, and steamship lines never dream of doing either. I suggest that they co-operate with the public more in this and other matters. If we could go to some agency and book an inclusive passage through South America at an inclusive price, so as to be sure of returning at a given date, it would be a great step gained. Co-operation, publicity, and enterprise are what is wanted, and with these the next ten years should see an enormous advance in South American travel.

Sir THOMAS HOLDICH: My experience in South America and in boundary delimitation never took me as far as Bolivia, and after hearing Major Fawcett's description of that charming country, I can only say, with Sir Martin Conway, how glad I am I was not there. It is on an occasion like this that we miss the voice of our great South American expert, Colonel Church, who has passed from us. He had always something interesting to say, and something new, but he never told us of such remarkable experiences as those which Major Fawcett has described to-night, and I was not prepared to hear anything like so much of the extraordinary difficulties of dealing with boundary demarcation in Bolivia, after my own experiences further south. I think that this Society may take to itself very great credit for having turned out a surveyor of Major Fawcett's capability. If we can only succeed in putting a few more men like Major Fawcett into the field (as he himself proposes), I think that our geographical school may well say that it justifies its existence.

The PRESIDENT: Geographers have on several occasions expressed surprise that these interior wild regions of South America have not been more thoroughly explored. Major Fawcett has expressed that opinion, but I think he has given better than any one else the reasons why travellers have not more frequently pushed into the interior. The obvious reasons are the discomfort, the difficulties, and the dangers of such journeys, for the picture he has drawn us has been a picture of famine and death, with a background of insect bites. The work he has so well described to us has been an admirable bit of work. Major Fawcett will, I am sure, never get over his love for exploring, and he is, in fact, about to set forth for South America once again. He will go forth with the most hearty good wishes of every one in this room, and of the Society which I have the honour to represent.

PROGRESS OF SURVEY IN THE ANGLO-EGYPTIAN SUDAN.*

By Captain HUGH D. PEARSON, R.E., Director of Sudan Surveys.

WHEN the campaign of 1896–98 was entered upon, we possessed, thanks to explorers from nearly every nation in Europe, a rough general knowledge of practically the whole of what is now known as the Anglo-Egyptian Sudan.

* For much of the matter in the early part of this article I am indebted to old reports written by Colonel Talbot.

Sir William Garstin, in his lecture delivered before the Society in December, 1908, dealt more particularly with Nile exploration and its results. In the present article I propose to outline very briefly the survey operations carried on during Sir William Garstin's second period, viz. from 1898 to the present day, dealing with the Sudan as a whole, without special reference to the river.

The area of the country which we, in conjunction with Egypt, assumed responsibility for after the battle of Omdurman amounts to approximately 950,000 square miles. A continuous network of primary triangulation covering this vast area must have taken many years to complete, and would have cost a sum of money altogether out of proportion to the value of the country.

Survey, however necessary and economical in the long run, brings in no immediate return, and with a revenue estimated at but £E.8000 in the year 1898, it was hardly to be expected that money would be forthcoming for the purpose. The revenue has at the present time reached one million sterling, but the calls on the Government purse have increased in proportion, and it has been necessary to make the most of the very limited resources at our disposal.

To the north of the Sudan rain is scarce and desert predominates, and, except in the immediate neighbourhood of rivers and khors, cultivation is practically non-existent. Minerals are to be found near the Egyptian boundary and along the Red sea. In the Halfa and Dongola provinces hardly a square metre of land which can be made cultivable is allowed to lie fallow. The close investigation of rivers and khors, with a view to adding to the areas which can be made productive, is therefore of importance.

South of Khartum, in a country of moderate rains and good soil, are the gum forests, a very valuable source of revenue. In years of favourable rainfall, the land is very largely cultivated. The most thickly populated part, however, between the Blue and White Niles some 50 miles south of Khartum, is precisely that part where the rains are most uncertain. It is from this zone that the first real advance in the development of the country may be expected, and the prosperity of the Sudan largely depends on the possibilities of irrigation.

Further south, again, is the country of the Negroid tribes, a country of torrential rains, where at present only sufficient land is cultivated for the very modest local needs. The southern Sudan is rich in cattle, and may prove valuable for rubber and rice plantations, but its importance is chiefly due to the fact that it is from the upper Nile that Egypt must look for an increased water-supply.

The considerations, then, that have governed the policy of the Survey Department have been, in the first place, the necessity of good general maps for administrative purposes, showing clearly the lines of communication. As no general scheme was possible, except at prohibitive

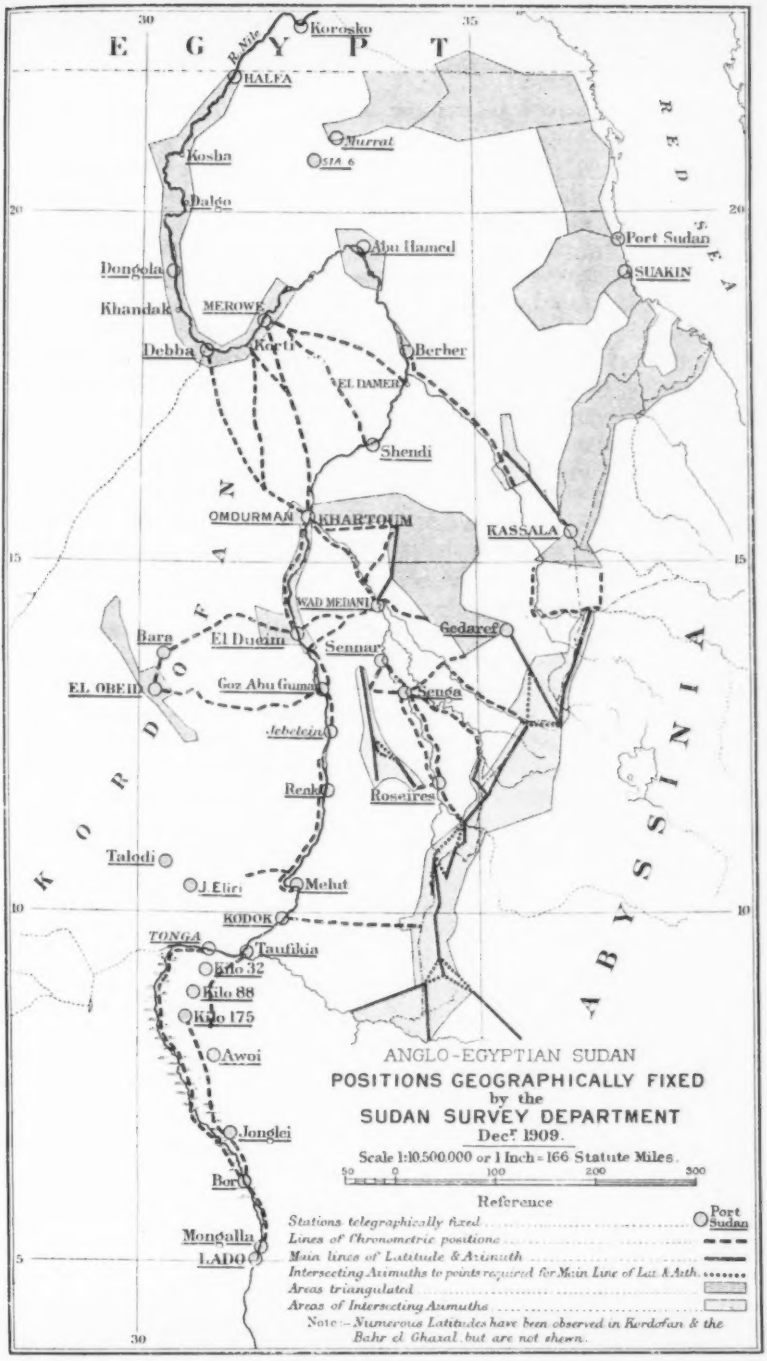
cost, it has been left to local requirements to indicate from time to time the directions where more detailed survey was desirable. Thus the boundaries of mining concessions were the primary cause of triangulation in the neighbourhood of the Murrat wells; the Abyssinian and Eritrean frontiers necessitated a detailed survey of the eastern boundary; cadastral survey and land concessions, involving the investigation of native rights, have demanded maps of a high degree of accuracy; and irrigation questions have been responsible for the closer exploration of the upper Nile and Zeraf rivers.

The several surveys have thus been started independently for the definite purpose required, and the work of connecting the various triangulations has been left till opportunity occurs. For the rest, the survey staff available have been hurried from one part of the Sudan to another to enable maps of the degree of accuracy necessary for administrative purposes to be produced at the earliest possible date.

The survey has been regarded from a practical point of view only. A high standard of accuracy is uncalled for, no hills have been contoured, and the 5-inch micrometer theodolite is the largest instrument used.

Colonel Talbot, the first director of the Sudan Survey Department, had, while at Halfa in 1893, fixed that place by telegraphic comparison with Cairo, and started a small triangulation. In the same year he accompanied a patrol into the western desert and fixed the position of certain wells. The year following a triangulation was commenced from Suakin, based on the positions shown on the Admiralty Chart. In 1896 a triangulation was started from Murrat, and, with the advance to Dongola, the Halfa work was carried south to that point. During the next two years, Colonel Talbot continued, whenever the time could be spared, to fix positions along the Nile valley. Merowi was telegraphically fixed, and a small triangulation commenced. Points between Merowe and Abu Hamed were determined, another triangulation started from Korti, and in 1898 a number of positions were observed while accompanying a force marching from Merowi *viâ* Jakdul to Metemma. It was in this year, also, that the Marchand expedition, which had traversed the Congo-Nile watershed and marched through the Bahr-el-Ghazal, arrived at Fashoda, materially adding to the information we possessed of the Southern Sudan.

In 1899 operations were undertaken by Colonel Talbot to fix telegraphically the position of Omdurman. The Mahdi's tomb was selected as the best point of reference, and a triangulation was commenced. In January of the following year, however, Colonel Talbot had to leave for Kassala for the purpose of arranging the Sudan-Eritrean boundary with the Italians. A base was measured at Kassala, and a triangulation started, which was afterwards carried north by Major Gwynn, and joined on to the 1894 work. Observations were then carried on between


E G Y P T
R. Nile
Korosko
HALFA
Murrat
SIA 6
Kosha
Dalgo
Abu Hamed
Port Sudan
SUAKIN
Dongola
Khandak
MEROWE
Debba
Korti
Berber
EL DAMER
Shendi
OMDURMAN
KHARTOUM
KASSALA
WAD MEDANI
Bara
El Dueim
Sennar
Gedaref
EL OBEID
Goz Abu Guma
Senga
Jebelein
Renk
Roseires
Talodi
J Elir
Melut
KODOK
TONGA
Taufikia
Kilo 32
Kilo 88
Kilo 175
Awoi
Jonglei
Bor
Mongalla
LADO
KORDOFAN
ABYSSINIA
ANGLO-EGYPTIAN SUDAN
POSITIONS GEOGRAPHICALLY FIXED
by the
SUDAN SURVEY DEPARTMENT
Decr 1909.
Scale 1:10,500,000 or 1 Inch = 166 Statute Miles.
50 0 100 200 300
Reference
Stations telegraphically fixed
Port Sudan
Lines of Chronometric positions
Main lines of Latitude & Azimuth
Intersecting Azimuths to points required for Main Line of Lat. & Azth.
Areas triangulated
Areas of Intersecting Azimuths
Note:—Numerous Latitudes have been observed in Kordofan & the Bahr el Ghazal, but are not shewn.

Suakin and Khartum and resulted in a new longitude being accepted for the former place.

In 1901 and 1902, Colonel Talbot had to revisit Murrat and to proceed to Deraheib in connection with mining concessions. The Murrat triangulation was continued east and west.

Several Egyptian officers had now joined the department. They were chiefly employed with subtense instruments in sketching the rivers, the Nile, the Rahad, the Dinder, the Atbara, and their work, checked by latitudes and chronometric longitudes, was extended in directions where less detailed sketching sufficed. Positions were fixed between Omdurman and Wad Medani, across the Gezira between Wad Medani and Dueim, between Dueim and Obeid, between Wad Medani and Gedaref, and up the Blue Nile to Roseires.

During 1902 and 1903 Major Gwynn was almost exclusively employed on boundary work. The triangulation commenced at Suakin and connected to the Kassala work was carried a considerable distance south till it gave way to latitude and azimuth fixings. Further south still from the Sobat to Lake Rudolf, Major Austin's expeditions had supplied much information.

In 1903 it became necessary to fix the point of intersection of the 5° 30′ parallel of latitude with the Bahr el Jebel, the northern boundary of the Lado Enclave. A number of places were fixed during the journey, and Captain Lyons and Mr. Craig added information, enabling a fairly accurate map of the river to be produced. In the same year Major Liddell and Captain H. H. Wilson were at work in the upper Nile provinces, and Captain Lloyd made many useful sketches in the northern part of the Kordofan province.

The Survey Department itself still consisted of two Englishmen only, assisted by four Egyptian officers, but by this time much information, usually in the form of time and compass sketches, executed by the province officials, was being received in Khartum. It was possible to make use of a number of these sketches at once, but others could not be utilized without more fixed positions. Every endeavour was made by Colonel Talbot and Major Gwynn to provide the positions necessary, either by latitude and azimuth, or by latitude and chronometric fixings. Points were so determined between Kassala and Geili and Khartum, between Omdurman and Korti, Korti and the Bayuda wells, Merowe and El Damer, etc.

In 1904 Major Liddell explored a telegraph route south of Taufikia to the Twi country, and observed latitudes and chronometric longitudes at Meshra, Wau, Tonj, Rumbek, and other stations in the Bahr el Ghazal. Mr. Dupuis with Captain Wilson fixed many positions on the Khor Filus and on to Bor, and a number of latitudes were observed by Captain Lloyd during his expedition to Rikitas.

The need of cadastral surveys over the cultivated areas now began

to be felt. A commencement was made in the Dongola province by surveyors lent to the governor. The maps produced were all that was immediately necessary to arrive at the areas of properties, but they rested on no framework, and could not be joined together so as to give a general map on a smaller scale. The method adopted was simply a plane-table survey of collections of sagias (plots of land irrigated by water-wheels), executed by means of telescopic alidade and 20-metre chain. The scale was 1 : 2500.

At the end of 1904 Major Gwynn resigned his appointment, and early in the next year Colonel Talbot also left the country. During the time he had held the post of Director of Surveys fifty-five sheets of the Sudan on the 1 : 250,000 scale had been published, provisional sheets had been got out of the Kordofan province on the 1 : 500,000 scale, and four sheets had practically been completed on the million scale.

During 1905 cadastral survey almost exclusively occupied the time of the officers of the department. Work was started in the Berber and Khartum province, and a scheme prepared for dividing up the Gezira between the Blue and White Niles into "minute" squares. At the same time classes were arranged for training Gordon College and other Sudan schoolboys in plane-table work. This class of survey, applied merely to the fixing, by intersection or tape, of the boundary pillars of properties, has been very readily picked up by the boys. Instances have occurred, too, where the native labourer, employed carrying the plane-table to a new station, has been found to have correctly oriented and clamped the table ready for the surveyor, and more than one of these labourers are now among the regular plane-tabler staff of the Department. The work has reached a high standard of accuracy, and an error of as much as 2 metres in the position of a boundary pillar is very rarely found, while the draftsmanship displayed has been altogether surprising. Parties have been organized into sections of four plane-tablers, each under an Egyptian overseer, while two, three, or more of such sections are under the supervision of an English inspector. The Egyptian overseers are now gradually being replaced by the older and more experienced of the Sudan schoolboy plane-tablers.

The areas of properties are also taken out by native schoolboys, trained to use the planimeters and sliding scale, the computing office being under an English draftsman recruited from the Ordnance Survey Department in England.

Time did not permit of a triangulation being run down the banks of the Nile before the detail party were set to work. A series of closed traverses was accordingly substituted, and the traverse stations, iron pipes fixed in the ground, co-ordinated and plotted on to plane-table sheets, and the detailed mapping made in kilometre squares.

Halfa, Dongola, Berber, and Khartum provinces have now been

surveyed in this manner, covering approximately an area of 535,000 acres, the plots ranging in size from about 2 to 20 acres. In the Gezira, where survey is still going on, an area of 530,000 acres has already been mapped.

The expenditure on the Gezira work has been £E.29,600, which works out to a rate of 55 milliems per acre (about 1*s.* 1*d.*). These figures, which include the laying out of "minute" squares covering an area of 4000 square miles, together with the cost of the permanent iron beacons erected, do not, however, represent the true cost of the survey.

Difficulties of settlement have very seriously affected progress; the trouble in the Gezira, which occurred in the middle of the working season of 1907, certainly cost us six months' work, and the delay inevitable in starting new work, occasioned by problems of demarcation and registration, etc., have all combined to enhance the expenditure. It is probable at the present time, with the work in full swing, the cost would work out to about half the amount given above.

During 1906 Colonel Talbot's triangulation, which in 1897 had reached Dongola, was further continued to Merowi, ending at J. Barkal. The traverse run between the triangulation stations so fixed enabled the plane-table sheets to be fitted together and utilized for smaller-scale maps. In 1906, also, and the following year, Captain Coningham, who had joined in Major Gwynn's place, continued the Suakin triangulation through the hilly country bordering on the 22nd parallel, and effected a junction with the Murrat work and the work of the Egyptian Survey Department across the boundary. Captain Coningham then started work in Kordofan, but was recalled to accompany a patrol into the desert west of Dongola, and map the positions of the wells and tracks.

In the mean time the Irrigation Department had been busy running lines of levels and surveying the Zeraf and Jebel rivers. The telegraph line had reached Bor. To give points on to which the Irrigation Department surveys could be tied, an expedition was made up these two rivers, and telegraphic longitudes fixed at intervals.

During 1907 Captain S. F. Newcombe, R.E., was sent to the Lado Enclave to examine, in conjunction with Belgian Surveyors, possible routes for a railway connecting the Congo with the Nile valley. The Enclave is about to be handed over to the Anglo-Egyptian Sudan, and the large amount of information collected and the maps produced should prove of great value.

In 1908 the work started in Kordofan was continued, but, owing to unrest in some of the southern jebels, it was thought best to postpone operations. In the autumn, however, Captain Coningham accompanied the Nyima patrol, and carried on a plane-table triangulation for a considerable distance further south, adjusting his work to telegraphic positions fixed in the south of the province. As a result of these last

two years' work a backbone of fairly accurate work now runs from the wells in the desert west of Dongola, across the Wadi Melh, through Bara and El Obeid, on through the Nyima Jebels to Kadugli, Talodi, Eliri, and Lake No.

At the close of the operations in the Nyima Jebels, Captain Coningham marched to the western Bahr-el-Ghazal. It had been intended that he should follow as far as possible the course of the Bahr-el-Arab, but inter-tribal disputes rendered this inadvisable. Captain Coningham carried watches, and had a perambulator with him, and he also took the longitude instrument invented by Mr. E. H. Wade, of the Egyptian Survey Department. This instrument, the first of its kind, had been designed for observations of equal lunar distances, and it was hoped that a few longitudes might be so determined. The instrument had been put together in Egypt, and had hardly passed the experimental stage.

Captain Coningham found considerable difficulty in working it, and eventually cloudy weather and mosquitoes forced him to abandon his attempts. Fair values for longitude were, however, obtained by means of his chronometers and wheel for the position of Hofrat el Nehas and other stations, and the previous maps have been considerably modified. Captain Coningham is now at work in the Burun country to the north of the Sobat.

The maps of the Southern Bahr el Ghazal have been adjusted to the fixings assigned to places by Commandant Lemaire and the officers of the Belgian Expedition of 1904–1905, and the only large stretch of unexplored country remaining is that portion to the east of the Bahr el Jebel, south of the Sobat.

Since the necessity of cadastral survey became recognized, the two Egyptian officers, left to the department, have been so employed, and Captain Coningham alone has been available for purely topographical work. The cadastral survey sheets have been reduced to a scale of 1 : 50,000, and the topography in the immediate neighbourhood added. These sheets are now being reduced to furnish the first accurate map of the Nile valley south of Halfa.

The plan initiated by Colonel Talbot is being followed. His triangulations are being extended as opportunities occur and local conditions require. Advantage is taken of the extension of the telegraph system to fix wherever possible telegraphic longitudes. Latitudes are now observed by at least three Sudan officials, and connected with the survey department, who have been provided with spare instruments and coached in their use. Where the telegraph has not reached, and neither triangulation nor latitudes and azimuths can be run except at prohibitive cost, wheel and compass sketches are made and checked by chronometric longitudes and observed latitudes. Railway reconnaissances, telegraph reconnaissances, and the Irrigation Department's lines of levels and

explorations have furnished other lines of a considerable degree of accuracy.

The remainder of the topographical information we possess is due to the time and compass sketches executed by civilian and military officials. A very large number of such sketches, of varying quality, have been made, and the circumstances which have caused the members of the department to hasten from one part of the Sudan to another, have, at any rate, enabled a number of positions to be fixed, on to which the sketches can be adjusted. The last entry in the receipt book for these sketches is No. 560, and if any credit can be claimed from the fact that, at the present time, all but three sheets of the inhabited portion of the Sudan are available for issue on the 1 : 250,000 scale, it is to the Province officials that the chief share is due. Without their co-operation the maps must have remained to this day little more than skeleton sheets. One hundred and twenty sheets are now published and procurable in Khartum, fifty-five of these have been lithographed in England, twenty-one have been zincographed in Khartum, and the remainder are issued as sun-prints.

On the million scale, too, sheets have been brought out of the whole of the Sudan either in the form of sun prints or lithographed maps, and wall maps, made up of these sheets fitted together, have been issued to the head-quarter offices. It is gratifying to note the extent to which Sudan maps are used, as it is only from a general use that we can hope to hear of inaccuracies and omissions. During 1909 no less than 4200 sheets were issued from Khartum alone.

One consequence of the unorthodox method of survey adopted is that a very great deal of revision is always in hand, and often the only revision possible is a complete redrawing of the sheet. As time goes on and more astronomical points are fixed, and the triangulations joined up, the revision necessary should gradually diminish.

The difficulties of keeping the maps up to date are much increased by the fact that the positions of villages are constantly changing, new villages are being built, and the names, often called after the headman, alter as soon as the sheikh dies. As in other parts of Africa, it often happens that travellers, going over the same roads, will furnish entirely different names for the villages, hills, and rivers they have passed, and in many cases it is by no means easy to identify the routes followed.

At the present time no single sheet can be considered final, and many are of very doubtful accuracy. Practically, however, maps were required for administrative purposes, and, rightly or wrongly, it was felt that a map, however inaccurate, was better than none at all. Compilations have therefore been hurried on, and criticism invited in the hopes that even in the absence of the ordinary survey checks, something fairly reliable may be eventually arrived at. The map attached will, I hope, in some measure help to clear up a record of the present state

of the survey in the Sudan, which, I fear, will prove most difficult to follow.

Mention has been made above of the Cadastral survey work of the department. Town surveys have also been undertaken, and those of Halfa, Berber, Atbara, El Damer, Shendi, Rufaa, Singa, and Gedaref have been completed.

The town of Omdurman comprises some 10,000 compounds, and with building land reaching the fictitious value of 10*s.* per square metre during the boom of 1907, a systematic survey became indispensable. The work is now approaching completion. The scale 1 : 500 was adopted, the town cut up by main and subsidiary traverses adjusted to trigonometrical stations, and the detail plane-tabled in, in many cases from the tops of buildings. A maze of ruins existed, and often the only entrance to a particular plot was through the property of the neighbouring owner.

The natives are now rebuilding on a very large scale, and much of the time of the Town Survey staff is occupied in fixing the alignments of the new compounds so as to fit in to a scheme for a new and sanitary town laid out with the necessary roads and lanes.

THE DANISH NORTH-EAST GREENLAND EXPEDITION, 1906–8: PROVISIONAL RESULTS.*

By Dr. J. LINDHARD.

THE moving spirit of the whole undertaking, the expedition's founder and leader, was L. Mylius-Erichsen. He succeeded after unwearied toil in obtaining so much support for his projects, both from private individuals and the state, that the vessel of the expedition, the *Danmark*, was ready to sail in June, 1906.

Mylius-Erichsen's plan was to drive the vessel during the late summer of 1906 as far north as possible, and to establish at the most northerly point a large depôt for future sledge journeys; then to seek a winter haven for the ship in the neighbourhood of Cape Bismarck, and from here to map the unknown north-east coast with dog-sledges in the early part of 1907; in the latter part of the year to sail in the vessel southwards to one of the most northern arms of the Kaiser Franz Josef's fiord, whence the voyage home might be considered assured; and in the early part of 1908 to undertake a sledge journey across the mainland to one of the most northerly Danish colonies, this detachment rejoining the main party of the expedition in Angmagsalik, whence all would return home.

This plan had, indeed, in consequence of several circumstances, to be modified in various points. The most important alteration, which however had no serious effect on the scientific work, was that the

* See *Geographical Journal*, vol. 33, p. 40, and map, p. 116.

vessel remained at its anchorage, "Danmarkshavn," in 76° 46′ N. lat. and 18° 30′ W. long., from its arrival at the coast in August, 1906, till our departure in July, 1908.

In the following pages I shall describe the work executed by the expedition during the period mentioned, and give some account of the material brought home and the preliminary results. A general survey of the scientific material will be published, partly in English and partly in German, in the *Meddelelser om Grönland.*

The chief aim of the expedition was geographical survey, its extent and limits being determined by the work of former explorers.

In 1870 the sledge party from the *Germania* expedition reached lat. 77° 2′, but owing to unfavourable travelling conditions the mapping work became very defective even at 75° 43′, the coast about Teufel cape and in Dove bay, as well as the outer land near Cape Bismarck, remaining quite unexplored. In 1905 the *Belgica* sailed along the outermost islands from about lat. 76° to 78° N. This expedition succeeded in determining in general the coast-line up to 78°, and ascertaining the existence of land up to about 79°. From 79° to 82° the land was entirely unknown. In 1892 and 1895 Peary travelled from Cape York over the inland ice, and in lat. 81° 40′ N. and long. 35° W. came to land which he naturally assumed to be part of the east coast of Greenland. He at the same time found that a large fiord or sound stretched from the east to the south of Peary Land, so that this must be assumed to be an island. In 1900 Peary travelled northwards from Cape York, passed the northern extremity of Greenland, and proceeded down the east coast as far as 83°. The last stretch of coast was less exactly surveyed owing to unfavourable weather.

The task of the *Danmark* expedition was, therefore, to map the east coast of Greenland from 75° 43′ northwards to about 83° 30′, a distance which might be estimated beforehand at not less than 620 miles. All the work was accomplished by sledge-journeys, as the ice conditions rendered it impossible to take observations from the ship. The instruments consisted of six small Hildebrandt travelling theodolites with their compasses, six pocket chronometers, six Zeiss binocular field-glasses, pocket aneroids, sling thermometers, etc.

The annexed sketch-map * gives some idea of part of the results. Especially noticeable is the fact that Greenland extends much further eastwards than had been expected. The unknown part of the coast-line proved to be fully 180 miles longer than calculated, and to enclose an area of about 13,000 square miles. The sketch-map is compiled from a calculation of the most important observations.

The material collected comprised—

A. Astronomical determinations, including azimuth readings, executed at about 160 stations.

* See previous note.

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E. Artistically executed sketches in pencil, about 120 landscape paintings and sketches in oil, as well as very numerous photographs.

Besides the general geographical survey, triangulation and base measurement were included in the programme of the expedition. Such work was considered desirable, partly as a groundwork for special maps, partly to render possible a connection with the German triangulation on Shannon island and Hochstetter's foreland, and lastly in connection with the proposed investigation of terrestrial refraction. The base-measurement was carried out on a level stretch just to the north of the permanent observatory, which, in summer a swamp, was at the time of the measurement frozen and partly covered with snow. The terminals of the line were marked by two bronze standards secured in solid rock. The measurement was made with a 24-metre steel ribbon, which had been adjusted at the standard base of the General Staff, in Copenhagen. The line was measured nine times in all, and the preliminary calculation gave as result a length of 1450 metres (4757·2 feet).

In September, 1906, the work of reconnoitring and erection of marks was proceeded with at twelve stations in the environs of Danmarkshavn. A cylindrical pillar was carefully built up, and its axis formed by a bronze rod, which was driven into a hole bored in the rock. The measurement of angles was continued from September 8 to 28, 1906. Horizontal angles were measured in three sets, vertical angles (trigonometrical levelling) in two sets. To obtain a starting-point for levelling, the zero point from the expedition's water-level measurements was carried to a zero post on land, and thence in a loop on to the permanent observatory and the ends of the base. At the end of the same year the permanent observatory was connected with the triangulation network.

These preliminary observations were executed in the first winter. The following year the triangulation network was extended westwards to the Orientirung islands and Hvalros (walrus) point and southwards to the Haystack, whereby a connection, though somewhat uncertain, was effected with the survey of the *Germania* expedition, so that it was possible to take advantage of this expedition's determinations of longitude and those carefully executed by Sabine on the Pendulum islands.

In view of the importance of detailed maps, not only for the topographical description of the country, but also for other scientific

investigations of the expedition, ethnographical, botanical, and zoological, the following works were executed :—

1. Plane-table survey on the scale of 1 : 50,000 of Danmarkshavn and its surroundings, 52 × 52 centimetres (20½ inches). Area included about 260 square miles, but a large part of it water. The relief of the ground was indicated by contours at intervals of 10 metres (33 feet).

2. Plane-table survey on the scale of 1 : 100,000 of Danmarkshavn and its neighbourhood, 52 × 52 centimetres. Area about 1040 square miles, more than half being water. This map extends on all sides beyond the limits of the foregoing. The relief is similarly indicated.

3. Map on the scale of 1 : 2000 of the wintering station. This map, 26 × 21 centimetres (10¼ × 8¼ inches), shows the position of the ship, the situation of the storehouse, the observatory, the meteorological, the magnetic and electricity of the air installations, etc. The relief is shown by contours at 1 metre intervals.

4. Map of the Gnipa cavern on the scale of 1 : 4000; contours at 5 metres (16·4 feet). The map, in consequence of the nature of subject, can only show the surface of the ground and indicate the situation, extent, and breadth of the cave with the relief of its bottom. The cavern being a unique occurrence of peculiar character and of particular glaciological interest, a longitudinal section was drawn, as well as a large number of cross-sections, and photographs were taken.

As the surveys 1 and 2 represented only one of the characteristic landscape forms, namely, the *moutonné*, there was surveyed map—

5. A map on the scale 1 : 50,000 of the plateau country at Pustervig and Mörkefiord. The relief will be shown by hatchings.

Lastly, in order to give a graphical representation of the chief geographical conditions affecting the peculiar bird fauna of the swampy district west of Storm cape, in the summer of 1908 was compiled—

6. An ornithological map of the area mentioned. The map, on the scale of 1 : 25,000, embraces an area of about 15 square miles.

In connection with the cartographical work the following problems had to be solved :—

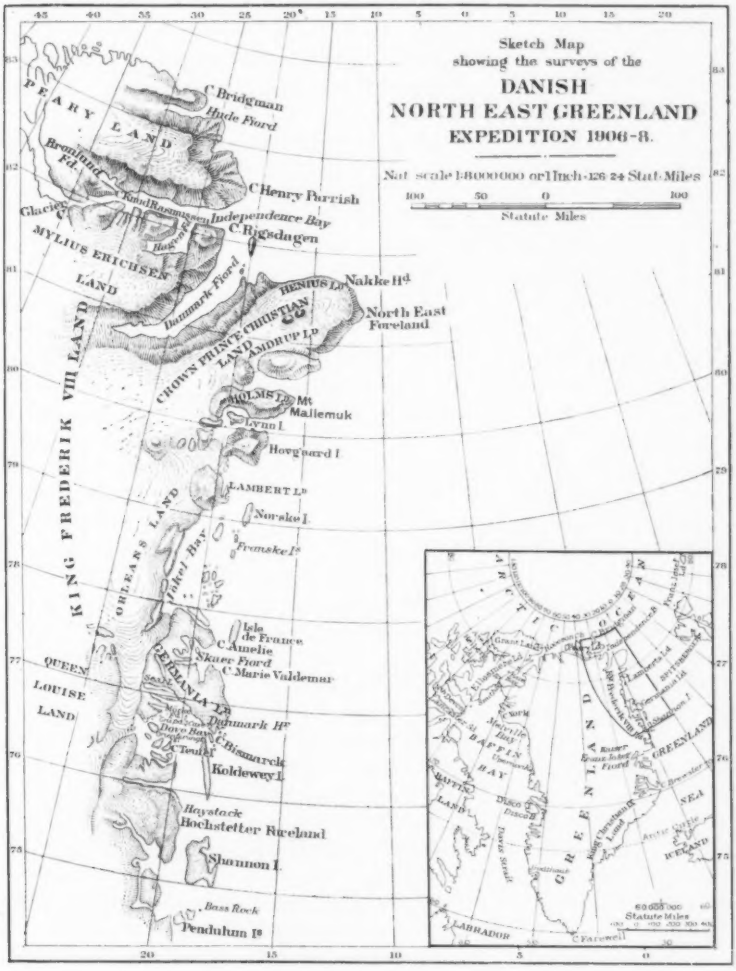
Determination of the geographical co-ordinates of the winter station.

Azimuthal readings for the orientation of the triangulation network.

Determination of the local time.

In September, 1906, the observatory was installed on a granite pile, which was firmly fixed in the ground with cement. On the pile, and securely fastened to it, was an iron plate, on to which the instrument, a Hildebrandt theodolite, with its micrometers, was screwed. Latitude observations were made in the latter part of 1906 by zenith distance measurements of two stars near the meridian on either side of the zenith. When later observations had been taken to determine the sidereal refraction there was material to ascertain the latitude with any desired degree of exactness.

It was intended on a sledge journey in November, 1906, to transfer the time from the Pendulum islands to Danmarkshavn with the aid of three pocket chronometers. The attempt failed owing to the difficult



travelling conditions and the awkwardness of using the chronometers at the very low temperature. As the determination of the longitude by trigonometrical methods in September, 1907, could not be considered reliable, the longitude was obtained from the movements of the moon.

The method of lunar azimuths was adopted, which was well suited both for Arctic conditions and for the instrument of the expedition. Altogether, lunar azimuths were measured twenty-one times, with forty-two corresponding determinations of time whence material was obtained for twenty-six pairs of independent values of longitude. Azimuth observations were made of the polar star at its greatest meridian distance. Almost all the time determinations were transit observations of a polar star, the stars α and λ *ursæ minoris* being used. In summer, of course, the time had to be fixed by zenith distances of the sun.

The astronomers of the *Germania* expedition were led by a regular difference in solar observations for time, morning and afternoon, to the conclusion that the refraction of light in East Greenland must be less than that given in the tables of Bessel and others. To settle this question a series of investigations into sidereal refraction was instituted. The observations took exclusively the form of zenith distances near the meridian for the determination of latitude.

In summer the sun had to be resorted to exclusively. In general, six readings were taken at the upper and lower culmination of each limb of the sun, grouped so that the meridional zenith distances could be conveniently calculated both for the upper and lower limb. In all twenty-eight sets of twelve zenith distances of the sun were taken. In the latter part of 1907, meridional zenith distances—single observations—were made of fifty fixed stars, so grouped that they were distributed at about equal distances on both sides of the zenith. Some of the solar observations were worked out, and as these showed no clear agreement with the tables issued by the *Germania* expedition, a series of experimental solar time determinations was taken morning and afternoon, as well as intermediate determinations at night in the vertical of Polaris. Neither did these observations seem to give results in the direction indicated by the *Germania* expedition.

As terrestrial refraction, both as regards its absolute value and its variations, is of great importance on a geographical exploration, where one cannot always choose time and opportunity for observations, a special series of investigations was instituted with regard to this phenomenon. A scientific determination of periodic refraction constants could not be effected with the means available, but results sufficient for practical purposes might be expected.

From August to October, 1907, reciprocal simultaneous zenith distances were measured five times over the land between the fixed observatory and pillar X., and once over the water between the observatory and a rock. The distances between these points were about $4\frac{1}{2}$ and 6 miles respectively. For the measurements the fixed instrument was used at the observatory, and at the pillar and reef one of the small portable alt-azimuth instruments. In view of the different conditions at the two terminal points, 2×20 readings were taken each time from

pillar X. and from the rock, while the simultaneous observations at the observatory consisted of 2 × 8 readings. The interval between the two groups was about five hours, during which levellings were executed from the observatory to the pillars V., IX., and X., as well as to the reef.

To ascertain the refraction variations a series of levellings was executed in two sets to the pillars V., IX., and X., as well as to the rock mentioned, and to the horizon at three different points. These measurements (in the summer of 1907) were frequently executed at the same time with balloon and kite ascents, or with special meteorological observations at the crow's nest of the ship.

Altogether fifty-three double sets were obtained to the pillars and rock, forty-seven single sets to the three points on the horizon, and thirty special levellings to pillar X. As expected, the levellings proved that the refraction is subject to very considerable variations.

Geologically, the country exhibits great uniformity; the archæan massive extends out to the coast along far the greater part of its extent. There are, however, in some parts high plateaus, as round Mörkefiord and Seal lake around Skærfiord, and also alpine country occurs in Queen Louise's Land, in a limited extent at about 80°, and Peary Land. Sedimentary rocks occur in a very small belt along the coast, and as a rule in fairly undisturbed beds. Late eruptive rocks are not to be found either in association with sedimentary deposits or elsewhere. Large palæological collections were brought home from various sources.

In the southernmost region, Hochstätter's foreland, the fossils were in a bad state of preservation and collection was difficult, for the land at the time of investigation was still covered with snow; but still the material brought home shows that the view hitherto held of the Tertiary age of this formation cannot be maintained. Covered by the lofty bed-rock which forms the western side of the large Koldewey island are found on the east side of the island Jurassic deposits with many well-preserved marine fossils. The beds form a plateau about 390 feet high, overlying gneiss, and are very conspicuous in some fissures out towards the sea. In contact with the Jurassic deposits but not overlying them is found a less extensive, much disturbed, deposit of late Cretaceous rocks.

In the region west of the ship's harbour is a considerable extent of raised sea-bottom, a singularly undulating country, consisting of sand-banks up to a height of 490 feet, which in section was seen to consist of quite loose sandstone, with belts of lime and a very fine seam of coal. At one place were found half-petrified bones of a large whale. The raised bottom was of large extent, and attained a height of some 1600 feet. Bivalve shells were found on this formation up to a height of 800 feet.

In the most northerly part of Germania Land, at the edge of the ice-stream which descends to the south-western point of Glacier (Jökel) bay, a bed containing fossil plants was found in a ravine. The fossils brought home from here were not so well preserved; their age is not yet determined.

By far the largest and most interesting sedimentary deposits occur to the north, between lat. 80° and 81°, where they form grand elevations on the south side of Holms Land and partly along the southern coast of Amdrup's Land. The material collected seems to show from a preliminary examination that these beds must be referred to the Carboniferous system, and in the circumstances of their bedding they bear a close resemblance to the early Carboniferous strata of Spitsbergen.

The coast land is bounded to a great extent by inland ice on the west and ice-covered sea on the east.

The glaciological investigations dealt chiefly with the winter harbour and its immediate surroundings, 76½° to 77°, but were also extended over all north-east Greenland from 75° to 83½°. While a broad coastal zone with prominent elevations occurs at Scoresby sound and Franz Josef's fiord, the ice-free land farther north becomes lower and narrower, and west of Danmarkshavn, where the heights are everywhere less than 3300 feet, the inland ice runs out to the sea in a glacier 12 to 18 miles broad. North of the winter harbour, the ice-free strip becomes still narrower, and from the neighbourhood of Lambert's Land a continuous coastal belt does not exist, but only some patches separated from one another by broad tongues of ice. Yet north of Lambert's Land, between 79½° and 80¾°, occurs a high mountainous land, intersected by numerous fjords, which blocks the course of the inland ice and at the same time has protected the sedimentary rocks lying here from glacial abrasion; but north of 80¾° the land sinks quite down; the coast-line disappears almost entirely under the inland ice. In relation to the small precipitation in north-east Greenland, the ice-mantle may be considered to be very extensive. On the other hand, the mountainous Peary Land, as far as may be judged from Peary's and the *Danmark* expedition's journeys, is almost clear of inland ice.

From the glacier, 25 miles broad, south-west of Lambert's Land, the ice streams out over Glacier bay, between 78° and 79° N. lat., which is covered and almost entirely filled up with a continuous mass of inland ice. Only the south-west corner of the bay is free of inland ice; it is instead full of calved ice from the glaciers, which here reach to the water. Only occasionally do the ice-floes escape from the bay; as a rule, they melt or evaporate away on the spot.

The ice in Glacier bay has most of the features characteristic of the marginal zone of the inland ice—fissures, undulations, reports produced by thawing, just as, also, the structure, stratification, and

surface moraines show that one is really on inland ice; but in other respects this ice exhibits striking peculiarities, due to—

(1) That the ice is for the most part afloat;

(2) That the surrounding sea is always covered with sea-ice.

The results are, firstly, that the crevasses are not very deep, scarcely anywhere more than 115 feet, and that the bottom is horizontal and covered with salt ice; but a far greater effect on the character of the ice is exercised by the great compression caused by the tide. This is due to the same cause as is active where the ice-sheet breaks off from a glacier or at the formation of an ice-foot—the rending and pressure of tidal water in an ice-bound fiord. The result, however, is different, an ice-foot, for instance, being a very rare occurrence.

When the sea outside is free of ice, the ice which breaks loose in the tidal water produces calf ice or icebergs, and is carried away, while the margin of the inland ice stands up like a wall, as is the case far north on the east coast of Greenland, between 80¾° and 81¼° N. lat., where the open sea is in direct contact with the inland ice, just as occurs in the Antarctic regions; but at Glacier bay sea-ice bars the way and the ice-sheet remains in its place or is crumpled up. In consequence of the movement of the whole ice mass out from the coast, the crushed ice is gradually worn down and at length loses its character. The area of compression thus contains parts within which the ice rests on the bottom and outside which it is floating. Here the under side is attacked by the salt sea-water, thins out, and finally is lost in the sea-ice. The peculiar circumstances thus cause the transition from inland ice to sea-ice to become quite effaced, and in the early part of the year, when the snow-mantle is thick, one may drive half-a-day's journey without being able to decide whether one is on land or sea-ice. Such conditions as in Glacier bay are met with in the broad fjord north of Lambert's Land as well as between Danmarksfiord and Nakke (occiput) head.

South of the north-easterly sweep, on the other hand, where open sea runs right up to the coast, one finds, as already mentioned, an ice-wall about 30 miles long with a height attaining to 50 feet.

In March and May, 1908, two sledge-journeys were undertaken over the inland ice. The goal of these journeys was a mountainous country, 5000 to 6500 feet high, lying about 90 miles west of the expedition's winter haven, Queen Louise Land, which is entirely surrounded by inland ice. Neither of these journeys yielded absolutely new observations on the ice, but yet they contributed in no small degree to our knowledge of the conditions in the marginal zone (the surface and gradient of the ice, distribution of precipitation, snow limit, extent and structure of ground moraines, water-line at *nunataks*, etc.), and the excellent photographs obtained on these two journeys are of more than usual interest.

In the course of the winter huge masses of snow were piled up in the hollows, which the short summer was unable to contend with. Besides large sheets of firn occurring in abundance, in the later part of the year frozen remains of snowdrifts were seen in the valleys, and, especially in the river-beds in the valley bottoms, quite small firn-patches, beneath which the river had made its way and hollowed out the drift. Though the first breach is made by water, the excavation is continued by the circulation of air, and thawing and evaporation can produce caverns of considerable dimensions. The largest of these, the Gnipa cave, was more than 2600 feet long; its height varied from 13 to 65 feet, and its maximum breadth was about 100 feet. Dirty layers alternated with layers of transparent and opaque ice. In the central part where the cave was quite dark, the form was a very regular barrel vaulting, but towards the ends the structure was more variable. The reflection of light from the vaulting, the shining points of the icicles a yard long, and the fantastic forms of the ice lent this section of the cave a romantic beauty.

Besides the map already mentioned, and a complete description of the details, as well as investigations into the circumstances of the cave's formation, the expedition brought home a very large and very good collection of illustrations of the Gnipa cave.

Investigations of the sea were principally executed during the sea-voyages from and to the winter haven between 75° and 78°, but they were continued during the sojourn on land by sledge expeditions to the ice-covered fiords and lakes in which were constantly collected material. The results consisted chiefly of (1) a cross-section of the polar current from the Atlantic ocean-depth (about 1300 fathoms) across the current over the submarine plateau to the coast. In agreement with earlier researches an intermediate layer of warm salt water was found, above it polar water of lower salinity, and a bottom layer of colder and likewise highly saline water. In the middle layer, which was first detected by Ryder and afterwards was the object of a careful investigation by the *Belgica* expedition, with results agreeing well with those of the *Danmark* expedition, was found a temperature of 34·3° and a maximum salinity of 34·97 per mille, while the bottom water showed a constant salinity of 34·88 per mille, and a temperature of about 30°. In contrast to these layers, both originating from the Atlantic, the surface water has a salinity of only 32° per mille. This water forms the southwards-flowing ice-bearing polar current which seems to follow fairly closely the submarine plateau (30 to 220 fathoms deep), over which it has its greatest velocity. The velocity diminishes very quickly out towards the Atlantic depths, and also decreases towards the coast, where deeper water (247 fathoms) often occurs. The distribution of ice in the stream was the old familiar one: an outer zone, with somewhat scattered ice in small pieces; a central zone occupying the greater part of the current, with heavy pack-

ice several years old, and densest at the margins of the belt; and an inner zone of open coast-water with scattered ice, partly detached floes from pack-ice, and partly winter ice from bays and fiords. (2) A series of determinations of the fjord water's salinity and temperature. The water of the upper layer was cold and slightly salt, whereas in the deeper fiords, where the depths were over 800 feet, warmer (32·9°) and salter water (34·85 per mille) was found.

In a lake, lying about 30 feet above the sea, there was found at a depth of about 200 feet a temperature of 35·6°, and a salinity of 28° per mille. This salt bottom-water smelt strongly of sulphuretted hydrogen. The lake had an outlet to the sea by a broad and abundant river; its lower part, about 30 miles from the river head, was full of morainic deposits, the inland ice sending out a small glacier into the lake. Almost all over it floated broken calf-ice. (3) Investigations into the fiord ice, which showed that its conditions were very different in the two winters. About Danmarkshavn the fjord ice in the winter 1906–7 attained an average thickness of about 70 inches. It was hard and compact, and increased considerably in thickness at the beginning of winter and afterwards slowly. The maximum thickness was reached in March, and there was little diminution in April and May. The breaking up of the ice in the summer of 1907 was on the whole very incomplete. In the winter 1907–8 the ice in the same places attained a thickness of only about 47 inches. Early in the season, while the ice was still thin (about 8 inches), a heavy fall of snow caused it to be covered with water, which was turned into less compact, granulated snow-ice. This ice melted completely in the summer of 1908. Besides these measurements, current measurements were taken in various fiords, and a detailed sounding of the sounds at Danmarkshavn was executed.

In continuation of Dr. Krogh's researches in West Greenland * a series of simultaneous determinations of carbonic acid tension were made in the surface water and the atmosphere at the season when the sea was free of ice. Also a large series of carbonic acid observations in the atmosphere were made in different seasons with relation to respiration experiments.

At the ship's harbour continuous series of tidal observations were repeatedly recorded but the results cannot yet be given.

The meteorological investigations consist of the following observations. At the station Danmarkshavn the following instruments were read three times daily (8 a.m., 2 p.m. and 9 p.m.) from August 16, 1906, to July 21, 1908: barometer (mercurial), thermometer, psychrometer, hair hygrometer, and Wild's anemometer; also at 8 a.m. the rain-gauge and the maximum and minimum thermometers (as at Danish meteorological stations). During the whole stay the self-recording instruments for temperature and atmospheric pressure were in operation.

* *Meddelelser om Grönland*, xxvi.

In addition daily readings were recorded in the winter of 1907-08, of the same kinds at the Pustervig station about 37 miles west of the ship's harbour. The object of this latter station was to investigate the climate in the inner fiords as contrasted with the coast climate at Danmarkshavn. Interesting observations resulted both as regards the distribution of precipitation and particularly with respect to the polar föhn. For instance, it may be mentioned that a föhn, which at Pustervig brought the temperature 72° up, made the thermometer at Danmarkshavn rise only 48°. Lastly, at the Pustervig station temperatures were recorded at various heights on the slopes of the Monument mountain (about 2600 feet). These readings have an especial interest when compared with the results of kite ascents at the main station.

At the head station an especial investigation was made into the daily movements of temperature in the lower 100 feet during calm weather. With this object readings were taken once a month every two hours during twenty-four hours, and at various heights from the sea-ice to the crow's nest. The instruments employed were Assmann's aspiration psychrometer, a hair hygrometer, anemometer, and black-bulb thermometer. As a rule there was an inversion of temperature, which in the spring attained the considerable difference of 14°.

For the first time in the history of Arctic exploration kites and captive balloons were employed by the *Danmark* expedition for the systematic investigation of atmospheric conditions in the higher strata of the atmosphere. Altogether kites were sent up ninety-nine times and balloons twenty-six times to an average height of 3163 feet. The maximum height was for kites 10,200 feet, for balloons 8140 feet. The chief results obtained are already published.*

On mirage there is a large number of observations as well as good photographs, while repeated ascents of kites and balloons exhibit the peculiar arrangement of the layers of air which produce this phenomenon. Of other observations in the domain of meteorological optics may be mentioned those of solar halos, of which photographs were likewise brought home.

Observation of cloud forms revealed cloud formations characteristic of these regions, called in the mean time "föhn-clouds." These may be considered as waves of interference in a surface of discontinuity at a height of 4000 to 4200 feet, produced by friction against the high mountain land to the west of the station. Good photographs have also been brought home of cloud forms.

Lastly, material has been collected to illustrate the very sudden and unusually large variations of temperature which the thermograms from Danmarkshavn, and especially from Pustervig, exhibit, and for

* *Meddelelser om Grönland*, xlii. vol. 2, No. 1.

elucidating the polar föhn. Furthermore, there are numerous scattered observations on meteorological phenomena—insolation, depth of snow, and the quantity of snow in the atmosphere during snowstorms, etc., as well as a number of notes during the voyage of the vessel and during sledge journeys.

The proposed investigation into the electricity of the air could only be attacked in the summer of 1907. Once a month observations were made extending over twenty-four hours and dealing with the electrical potential of the air and its conductivity (Gerdien's apparatus). In winter there was necessarily a reduction in the plan of observation, but a certain number of records were obtained. Several short registrations were made of the electric potential (Benndorf's apparatus), the longest of which extended over little more than a month.

Once a month the three magnetic elements—declination, inclination, and horizontal intensity—were determined with a theodolite; the last, however, only till the end of 1907, as the instrument's mirror became useless. The record of declination extends over a year. During the measurements at Germaniahavn an attempt was made to ascertain the secular variation since 1870. Lastly, on sledge journeys a large number of rough determinations of declination were made.

The ethnographical work of the expedition was seriously affected by the loss, during a journey in 1907, of the leader, on whom research in this domain depended. In the latter part of 1906 some preliminary journeys were undertaken with an ethnographical object, so that the field of work was partly known in main outlines, but all the summer of 1907 was lost for systematic work. At the end of the year 1907 the secretary of the expedition (C. B. Thostrup) was deputed to continue Mylius Erichsen's interrupted investigations, and to his energy is due the collection of very considerable material.

As in other branches of inquiry, exact systematic research was confined to a small region, but from sledge journeys collections and notes were also obtained for the whole of the coast-line visited by the expedition. It was found that the country was uninhabited, but numerous remains were left indicating former settlements of Eskimos.

The material brought home consists of a large collection of ethnographical objects (more than twelve hundred), including all kinds of weapons and implements or fragments of them, as well as ornaments and domestic utensils. At 80° 24′ N. lat. was found a large collection, exclusively bone articles, at other places stone implements; no iron was found. It appears that women's boats and kayaks were known, and that sledge-travelling had reached a very high development. Among implements of the chase are salmon spears and bird bolts. Whetstones were scarce; lamps and cooking vessels are made of hard stone.

The kitchen refuse brought home shows that the extinct tribe subsisted on pretty nearly all the kinds of animals living in the country

(*Lepus variabilis*, *Myodes torquatus*, *Canis familiaris*, *Ursus maritimus*, *Rangifer tarandus*, and *Ovibos moschatus*), besides several marine animals (*Balæna mysticetus*, *Trichechus rosmarus*, *Erignathus barbatus*, *Phoca fœtida*, *Monodon monocerus*) and various birds (*Lagopus mutus*, *Anser segetum*, *Larus glaucus*). Of land animals, the musk-ox (*Ovibos moschatus*) seems to have been of great importance.

A quantity of human skeletons and fragments, including eight skulls,* were obtained from some burial-places. In some of these the teeth were worn away almost to the jaw.

In addition there are a large quantity of notes, comprising descriptions of localities and settlements, drawings of settlements, arrangement and measurement of certain ruins as winter houses, tent circles, meat pits, boat stations, graves, etc. A quantity of photographs were also taken.

To judge from the winter houses, it would seem that there must have been three different settlements. Between the first and second a considerable space of time must have intervened; while between the second and third there was a comparatively short interval. In the district round the winter harbour were found thirty-two of the oldest winter houses, twenty of the second period, and only four of the latest. This may indicate that two immigrations took place at a long interval, and that possibly the few most recent houses are the work of a remnant of the last tribe, which, after trying to reach other and better districts, had to make a return journey along the coast, and finally (as various finds point out) perished here. The ice-free land being here of small breadth, the Eskimos could not make annual journeys inland as they do in other districts, though there are traces of something of the kind in the inner parts of Dove bay at the south end of Seal island and at Rype mountain, where there was opportunity to hunt musk-oxen and reindeer, and also for salmon fishing.

If we consider the circumstances of the first case, we find that the earlier settlers were not spread over the long coastal strip, but were collected in groups at the most suitable spots, separated by more or less inaccessible and extremely barren stretches of coast. On Peary Land no ruins were seen and no trace of man, but elsewhere they occurred from Shannon island to C. Glacier, where the conditions rendered human residence possible, relics of a time when Eskimo tribes inhabited the country.

The ornithological booty of the expedition was unexpectedly abundant. After preliminary investigations at the close of the summer of 1906, continuous observations and biological inquiries were made in 1907 and 1908 in a specially selected district (of which a special map

* A large work on Eskimo crania by Prof. F. C. C. Hansen, Copenhagen, and Prof. Fürst, Lund, will soon appear.

on the scale 1 : 25,000 was afterwards drawn up), in which most of the birds existing in the country were found breeding, particular attention being paid to the breeding-places of such little-known species as *Tringa canutus*, *Calidris arenaria*, *Phaleropus fulicarius*, *Larus sabinei*, *Larus eburneus*, *Anser leucopsis*, and *Somateria spectabilis*.

Of all the species here mentioned, the ornithologist brought home an extraordinarily complete set of specimens, not only of full-grown birds, but also of eggs and young in different stages of development. Thus, for example, twenty-four eggs, and at least as many downy chicks, were collected of *Calidris arenaria*; also eggs of *Larus sabinei*, *Larus eburneus*, and *Phaleropus fulicarius*. Moreover, a breeding-place was noted of about thirty pairs of *Tringa canutus*. New for East Greenland was *Fuligula marila*, of which a specimen was brought home. The better-known bird forms are also fully illustrated, both fully developed birds and young ones and eggs; also photographs of flying birds, birds on the nest, and nests with eggs were taken.

The biological notes include exact dates of the arrival and departure of birds, remarks on the life conditions of all the birds, pairing peculiarities, enemies, etc., thorough investigations into the change of plumage of *Lagopus mutus*, etc. In the unfavourable summer of 1907 there was an opportunity of studying the serious inconvenience which the untoward conditions of the ice caused to birds whose breeding is dependent on open water. Besides this systematic work, many observations of ornithological interest were made during the journeys; thus important bird cliffs were noticed at lat. 80° 12′ and 80° 30′, where *Fulmarus glacialis* was observed breeding.

Abundant information has also been obtained regarding the occurrence of land mammals. On such a well-known animal as *Ursus maritimus* scarcely anything new can be said; yet observations on the mating and bringing-forth of the bear may arouse interest. Of *Canis lupus* there is a very full account, notes on its habits and mode of life; five specimens of the animal were obtained. *Canis lagopus* was also the object of a thorough biological investigation as to the shedding of its coat, breeding, and means of subsistence in the dark season.

With regard to *Mustela erminia*, so seldom obtained in Greenland, very full biological information was obtained. The collections were enriched with eight specimens—five in the winter, two in the summer, and one in the intermediate coat. *Lepus glacialis*, owing to its relative frequency and its remarkable fearlessness at most seasons, was an especially easy object of observation. Among other things a large collection of photographs was obtained of the living animals at close quarters. *Myodes torquatus* was a very interesting subject, as with the existence of the lemming was bound up that of several other animal forms. When the unfavourable weather in the winter 1906–7 reduced considerably the number of lemmings, it also produced serious interference

in other forms of animal life. Wherever the expedition travelled numerous traces of *Ovibos moschatus* were found—skeletons, excrements, spoor. The animal itself was seen only in small numbers, chiefly in the northernmost parts, in Danmarkfjord and in Peary Land. *Rangifer tarandus* had also left numerous signs of its former existence in the country, but the living animal was never met with.

With regard to the sea mammals only scattered notes have been collected. One of the most interesting is that *Trichechus rosmarus* kills seals for food. On one occasion a combat was witnessed, and on another occasion large pieces of seal skin and blubber were found in the stomach of a slain walrus.

The insect fauna * in the district round the winter harbour has in the main the same character as that of the southern region of East Greenland, and differs only in containing a small number of species. A peculiarity is that no representation of the order Coleoptera was found, nor do Physopodæ occur in the collection. On the other hand, *Hæmatopirnus trichechii*, not known hitherto from East Greenland, was found on a dead walrus.

Two species of wasps (*Praon sp.* and *Nematus sp.*) are new for East Greenland, and the latter has hitherto never been found in Greenland at all. The nests and grubs obtained of the two Greenland humble-bees show that their mode of life here is the same as in more southern places. Flies are represented by fifteen species, besides a couple that cannot be identified, and a large collection of larvæ. One species (*Catabomba grœnlandica*) is new. Almost all the hares shot were infested with fleas, as was found to be the case by the Swedish expedition on the east coast. Hare fleas were reported by O. Fabricius from the west coast, but have not been seen since his time. Of the nine butterflies one species (*Sericoris schultziana*) is new, and also a larva was found which belongs to none of the known species of butterfly. A bug (*Nysius grœnlandica*) was also new for East Greenland.

The collections of the sea fauna proper present great interest, particularly with regard to the contrast between the conditions of animal life in the seas of North and South Greenland. The material has not yet been completely worked up. Of the more interesting discoveries hitherto revealed may be mentioned a feather star (*Antedon prolixa*) with young in many different stages of development, a very valuable addition to the exceedingly scanty material hitherto known.

Botanical collections were chiefly made on the south coast of Germania Land, and particularly in the immediate neighbourhood of the ship's harbour, and on the rocks and small islands south of the harbour. But there is also a small number of plants brought from Peary Land, and a few from the *nunataks* west of Danmarkshavn. The vegetation

* From Dr. N. C. Nielsen's examination of the collection.

was scanty. In all about ninety species of flowering plants were brought home, of which one only (*Alsine rossii*) is new for Greenland. Small collections were also made of mosses, lichens, fungi, and sea algæ, as well as a quantity of plankton, the last during sea voyages. There are, besides, plants in spirits for anatomical investigation.

During the whole sojourn of the expedition in Greenland observations were made of conditions affecting plant life, the depth of the snow, the date of its disappearance, temperature readings in the under layer of snow and the surface of the ground, radiation of heat, evaporation, sprouting time, flowering season, seed nutrition, etc., so that very important biological data have been obtained.

In conclusion, I may mention that on the *Danmark* expedition physiological investigations were instituted on a greater scale than on any preceding Arctic expeditions. In spite of various difficulties a series of respiration experiments was successfully carried out for one individual; altogether there are about 120 experiments recorded. These are partly morning observations spread over the seasons to detect a possible annual variation, partly distributed over the hours of the day with regard to the daily period.

These tests established the frequency of respiration, the total amount of air respired (ventilation), the alveolar tension of carbonic acid, and the carbonic acid given off. A clearly marked annual period was detected with turning points at the end of winter and the end of summer, and characterized by a diminution in the frequency of respiration, and of alveolar carbonic acid tension from winter to summer, while the ventilation and metabolism increased considerably in the same period. The respiration characteristic of the Arctic summer, which showed a very striking similarity to that in a mountain climate, seems to be due to the effect of light.

A series of temperature readings was also taken to investigate the conditions governing the temperature of the body, and a trial was made in the Polar night of the frequently unsuccessful experiment to test the constancy of the daily temperature curve in the peculiar circumstances, when night is turned into day and *vice versâ*. Temperature curves of the inverse type were successfully obtained. Lastly, a number of blood samples were investigated with respect to the number of *Leucocytes* and the causes of their variations.

Perhaps it is as well to mention that by all work in which instruments were employed numerous tests were made of the advantages and drawbacks of the instruments under Arctic conditions.

THE OPENING OF THE OCEANOGRAPHICAL MUSEUM AT MONACO.

The Prince of Monaco, whose pre-eminent position as a practical oceanographer was recently recognized by the Royal Geographical Society, is not content with accumulating data and securing great collections from hitherto unsearched recesses of the ocean. It has long been his ambition to provide for the full utilization of his labours by men of science, and to this end he planned an Oceanographical Institute on a scale of magnitude and completeness such as has never been attempted by any other individual for any branch of science. The scheme includes two parts. The first of these is a School of Oceanography in the University of Paris, the buildings for which are now in course of erection, and the work of which is already being carried on by three professors: M. A. Berget for Physical Oceanography, M. L. Joubin for Biological Oceanography, and Dr. P. Portier for the Physiology of Marine Life. The school will be part of the University, but with an independent organization composed of a French Council and an International Committee on which the oceanographers of all countries are represented. The second branch of the Oceanographical Institute consists of a museum and laboratories at Monaco, the inauguration of which was made the occasion of a great international gathering, including the representatives of scientific societies, and most of the oceanographers of Europe, the accompanying festivities extending from March 29 to April 1.

The museum, which has been built of the local white limestone from the plans of M. Delefortrie, occupies a striking position at the southern extremity of the peninsula of Monaco, near the ancient palace of the Prince and the new cathedral and Anthropological Museum by the side of the beautifully kept gardens of St. Martin. The rocky front of the peninsula drops steeply into deep water, and the museum, which fronts the north, consists of two floors above the level of the summit of the peninsula, and of two, and at one point of three, lower floors looking to the south backed by the rock itself and extending downwards almost to the level of the sea. The ground plan of the two principal floors is simple, but of grand proportions. The building is 328 feet in length, consisting of a central portion 66 feet square, with two wings, each 131 feet long and 49 feet wide. The entrance hall and two great stone staircases occupy the front of the central portion which projects beyond the line of the wings, and leads into an inner Hall of Honour standing 175 feet above the level of the sea. A marble statue by M. D. Puech of the Prince of Monaco standing on the bridge of his yacht occupies the centre of this hall, which is lighted at night by a great pendant in the form of a medusa, the translucent body being illuminated

by numerous incandescent lamps, and four subsidiary lanterns at the corners of the roof are modelled on the pattern of radiolarian shells. Great folding doors open to right and left into halls occupying the wings of the building. The western hall is fitted as a lecture-room, and here the inaugural ceremony on the 29th and the banquet on the 30th took place. The windows are fitted with double blinds, one set white to reduce the glare of the sun, the other set black to darken the hall and admit of the use of the lantern for demonstrations during daylight. A platform runs along the western end, and the whole wall above it is filled by a great oil-painting showing the deep blue surface of the ocean ridged into rollers, with the white form of the Prince's yacht in

THE OCEANOGRAPHICAL MUSEUM, MONACO—FRONT VIEW.

the distance. The walls are decorated in blue, and the panels of the ceiling have pictures of the sea, ships, and marine creatures. The eastern hall is fitted with cases containing part of the collection of marine animals and oceanographical apparatus, and the corresponding hall on the first floor contains the remainder of the collection. The western hall on the first floor is used at present as a preparation room, but will ultimately be available for the exhibition of specimens.

It would take too long to describe, even in a cursory way, the contents of the various rooms. The collection of apparatus for physical oceanography includes historical forms as well as the most recent patterns. The specimens of marine organisms, though mainly the trophies of the Prince's own expeditions, are supplemented from

other sources, and are very clearly labelled in three languages. The nucleus of a most interesting exhibition illustrative of marine industries has also been arranged, and this is capable of great extension, and will appeal to many visitors to whom the scientific exhibits would mean little. Below the ground floor of the building there are two storeys devoted to laboratories, the director's room, workshops, and an aquarium, but these are in no sense basements, for, although the solid rock forms the northern wall, the windows on the southern side open to the air, with a full view of the Mediterranean. The view of the building from the sea shows how ingeniously the architect has not only founded his structure on the rock, but moulded it into the rock, so that when weathered by time it will be difficult to tell exactly where the work of Nature merges into the work of art. The illustration will give some idea of the dignity and grace of the building, the front of which bears the names of many of the ships famous in oceanographical research, such as the *Challenger*, *Talisman*, *Valdivia*, *Hirondelle*, *and Princesse Alice*. The two groups of colossal symbolic statuary above the central doorway are 26 feet in height, and represent on one side Truth unveiling the forces of the world to Science, and on the other Progress coming to the rescue of Humanity.

The museum is in charge of Dr. Richard as Director, aided by a staff of assistants, and a little steamer, the *Eider*, is attached to the institution to serve for collecting in the neighbouring waters, and for affording practical instruction to students in the methods of oceanography.

At the opening ceremony official representatives of several governments were present, including men of such distinction as ex-President Loubet; M. Pichon, the French Foreign Minister; Admiral of the Fleet von Koester, representing the German Emperor; and high officers representing the kings of Italy, Spain, and Portugal. Two French and one Italian torpedo-boat destroyers of the latest type moored in the harbour represented the respective navies. The Institute of France was represented by a number of its most illustrious members, the Academy of the Lincei in Rome, the Academies of Sciences of Berlin, Vienna, and St. Petersburg, and most of the leading Geographical Societies of Europe also sent members to express their sympathy with the inauguration. The British Government sent no representative, nor was any explanation of the omission to be found. We cannot doubt that a misconception of the importance of the occasion must have prevailed in the mind of some official, and that the invitation to participate failed to reach the proper quarter, for no Government in the world has spent so much money on oceanic research as ours, nor has any development of modern science been so distinctly British as oceanography. The absence of any personage of high official or social distinction from this country was painfully conspicuous, and the subject

of much remark and many questions uncomfortable to hear and difficult to answer. British scientific men were there in fair number, and the leading societies dealing with questions relating to oceanography sent delegates. The Royal Society was represented by Mr. J. Y. Buchanan, F.R.S.; the Royal Society of Edinburgh by Dr. H. R. Mill; the Royal Geographical Society by Dr. J. Scott Keltie; the *Challenger* Society by Dr. G. H. Fowler; Mr. W. E. Archer, of the Board of Agriculture and Fisheries, and Prof. W. A. Herdman, F.R.S., of Liverpool, were also there.

At the inauguration ceremony on March 29 the Prince delivered the address, a translation of which appears on another page, and at its conclusion the French Minister for Foreign Affairs, M. Pichon, congratulated him in very cordial terms on the auspicious occasion. Admiral von Koester conveyed the sympathy and appreciation of the German Emperor, and dwelt upon the unique character of the museum. Admiral Grenet conveyed a gracious message from the King of Italy; and Count de Souza-Rosa, in a most eloquent speech, spoke of the intense personal interest taken by the late King of Portugal, himself an ardent oceanographer, in oceanographical research—"One might say that the unfortunate king, jealous of his ancestors who had formerly caused the surface of the oceans to be explored by the valiant Portuguese navigators, had devoted himself to the still more difficult enterprise of exploring the most inaccessible depths;" and the young king had recently dedicated a museum in Lisbon to receive his father's collections. The Senator Odon de Buen conveyed the good wishes of King Alfonso. After the performance of a new cantata entitled "La Nef Triomphale," specially composed by M. Massenet, three short discourses on different aspects of oceanography were given by Professors Berger, Portier, and Joubin. Another new musical production, the "Marche Inaugurale," in which M. Léon Jehin the composer had happily introduced the stirring strains of the Monegasque Hymn, closed the proceedings, surely the most memorable with which any scientific institution had ever been opened.

In the evening there was a special performance of the Monte Carlo Opera Company, in the course of which an "Ode to Thought," specially written by M. Raoul Gunsbourg, was recited by the great French elocutionist, Mme. Bartet.

On March 30, after the banquet in the museum, the Prince proposed the toast of the Heads of States represented at the gathering. M. Emile Loubet, in the name of the Council of the Paris Oceanographical Institute, greeted the Prince of Monaco as a Prince of Science, whose remarkable work was the admiration of the whole world. Prof. Hergesell of Strasburg spoke in the name of the International Committee of the Oceanographical Institute; M. Emile Picard, in the name of all the Academies of Sciences represented, proposed the toast of the new discoveries which would result from the common efforts of men of

science of all nations in the domain in which the Prince continued to explore. M. Massenet, the composer, unable from illness to be present, sent a most eloquent address on the part of the Academy of Fine Arts, in the course of which he said, "That vessel which we see riding in the bay with the deceiving lines of a simple yacht destined for pleasure trips, you have snatched rudely from the calm of these sunny seas and driven towards the frozen oceans of the north, turning the sumptuous ship into a floating laboratory where life is led in serious researches after new truths." M. Périer for the Paris Society of Natural History and M. Gabriel Bertrand for the Pasteur Institute offered their hearty congratulations, and Dr. Scott Keltie, speaking for the Geographical Societies of Europe, expressed the high esteem in which the Prince's work and his successful enterprise in founding this museum was held by all students of geography. M. Girard, in the name of the Maritime League of Portugal, made a speech which concluded with the reading of the following touching message from the King of Portugal:—

"Girard, say to the Prince of Monaco, for whom I have so great a friendship and admiration, that from the bottom of my heart and more than any one else I associate myself with the opening of the Oceanographical Museum. You, better than others, know the reason, so dear and so precious to my heart as a devoted son who can never forget the work of his beloved father."

The other proceedings included various excursions, a magnificent firework display and pageant of the landing of Hercules in the harbour at Monaco, and a demonstration by Lieut. Bourrée, by means of the cinematograph, of the working of oceanographical apparatus on board the *Princesse Alice*, the representation having the illusion of reality to an extraordinary degree. It is the Prince's intention to have every operation of the manipulation of appliances reproduced in this way for use in the lectures at the Oceanographical Institute.

Four committees on scientific work redeemed the occasion from the charge of being a mere pleasure party, and these occupied the attention of oceanographers of all nations. As no report of these meetings has yet been issued, we defer a summary of the conclusions arrived at. The proceedings terminated with a state reception in the gorgeous Palace of Monaco, where the brilliance of the array of naval, military, diplomatic, and official visitors almost swamped the sober garb of the students of science gathered from all lands to hail the inauguration of this great gift to research.

OPENING ADDRESS BY H.S.H. THE PRINCE OF MONACO.

The ceremony which is taking place in the presence of a distinguished audience is evidence of the progress of a science which, though still young, is firmly established in intellectual life. Now the science of the ocean enters into possession

of this palace on which the architect has impressed the conception of his genius, thus fulfilling my desire of paying the same honour to the two directive forces of civilization—Art and Science. It enters into this palace, where the first echoes that have resounded among its walls and columns have increased the prestige of two leaders in the musical world.

Oceanography now owns fleets to explore the abysms, savants to develop its riches, chairs to educate its teachers and spread abroad its pursuit, and it is liberally supported by many powerful states and some enlightened individuals. Two exalted personages in particular have earned the gratitude of oceanographers. William II., German Emperor, has done much to confer on his country a glory superior to all human forms of ambition, namely, that which owes its life to the atmosphere of laboratories; and he directs his attention chiefly to the sciences connected with the sea. The Emperor extends his interest beyond the limits of his empire, for he has patronized the creation of this monument; has sent forth vessels to investigate the waters of the sea as far as the Indian ocean; has erected on the Peak of Teneriffe, one of the loftiest summits that rise above the waves, an observatory for oceanic meteorology; and, lastly, encourages by marks of his royal favour all, whatever may be their profession, who distinguish themselves by their scientific work.

King Carlos of Portugal devoted the best part of his leisure to the pursuit of oceanography, and he was giving a useful example to the science of his country when a crime, inspired in the lower depths of politics, and which broke in upon the progress of morality, terminated the life of this learned, artistic, and excellent monarch. Thus in our time, disturbed by the collision of an old current of barbarism with the ebullition of the modern spirit, we see wild waves flood fields of human nature which would be already protected if so many ancestral impulses had not rendered them a domain difficult to reclaim. But atavism, this restricted force which carries through successive stages of existence the influence of previous generations, yields but very slowly to a force eternal in the universe, the force of evolution, which draws men on to a future concealed behind the veil of time.

In speaking of science we must congratulate Germany and the Scandinavian countries, where both nation and state have felt that scientific culture contains the secret of civilization, where so many citizens constitute foci of intellectual development, where this culture guides the arrangement of ideas.

On an occasion like the present the audience will certainly recall to mind the memorable British savants who first overcame the prejudice against the possibility of life in the deep waters and carried out the glorious pioneer cruises—Carpenter and Wyville Thomson, John Murray and Buchanan. These recollections lead us to Milne Edwards, who was my master in the science, and Magnaghi, whose work opened the way for marine science in Italy; while oceanography expects from Charcot, Thoulet and de Gerlache, Vinciguerra, Agassiz, Steindacher, Nordenskjöld, Forel, and the noted German oceanographers further contributions to the great work of the illustrious phalanx. I also think of Spain, where, years ago, sailors of the old school taught me navigation, bringing me into such close contact with the sea that the union has become indissoluble. Nor do I forget that the Russians, with Bellingshausen, Kotzebue, and Linz, have, perhaps first, produced studies of the ocean waters which are still of great utility, forerunners of Makarof, who was snatched from the higher ranks of science by one of those wars which the most barbarous instincts of mankind still produce amongst us.

Here, gentlemen, you see that on the territory of Monaco has arisen a proud and inviolable temple dedicated to the new divinity which reigns over the intellect. As for me, I have lent the forces of my brain, of my conscience, and my

sovereignty to the extension of scientific truth on the only ground where the elements of a stable civilization can mature guaranteed against the inconstancy of human laws.

The analysis of recognized facts on the formation and course of the world, soon made it evident that the ocean had played the chief part in the series of causes and effects to which is due the first appearance of life. Then the investigation of the waters excited the enthusiasm of savants, as well as of the increasing multitude of those who understand the pleasure of knowledge and desire to oppose the brutal army of ignorance.

Oceanography has shown that even the abysses of the sea, far from being uninhabited, as badly informed savants formerly declared, are much more densely populated than the atmosphere, where life occupies a single level. Then it points to the basin of the seas, this natural crucible in which float in solution the elements furnished by the Earth for the formation of organisms, as the cradle of the first living cell. And hence we may believe that we, beings leading a terrestrial life, are refugees escaped from the ocean with the energy distilled in the bosom of the waters which furnishes our bodies with the forces of life and reproduction.

Are we happier under the brightness of the sun than in the phosphorescence of the abysses? in the rarefied and variable medium of the atmosphere than in the still space where centuries have watched the transformations of living substance? If pleasure is measured by the intensity of the sensations yielded by the spectacle of the movements of the universe, assuredly we are favoured; but it may be that true happiness lurks in the abysses where shadows pass in silence indistinctly lighted by phosphorescent gleams, where death succeeds so suddenly to life that the two mysteries are often merged together, and where the cruel notion of annihilation never penetrates.

Oceanography develops rapidly, because in the history of the Earth the present and former *rôle* of the ocean have attractions for all sciences. Accordingly, in view of the proportions of a work which extends from pole to pole over all longitudes, in all depths, and through all times, it has been my wish to combine the intellectual forces of all progressive countries in order to consolidate its foundation and direct its growth.

I have, then, established the institute the first section of which is opened to-day—these galleries, destined for material collected during my scientific life and for similar treasures to be acquired in the future; and the laboratories where I wish that oceanographers may make use of the means gathered together for the furtherance of the science. The other section, which will shortly be opened in Paris, is a centre of instruction situated in the very heart of the university and completely autonomous, whither the youth of the schools already flock to listen to the teachers I have appointed.

A French council, which includes some of the most eminent men, conducts the administration of the whole scheme, but an international committee, including the most prominent oceanographers of all countries, controls its scientific interests. And on the occasion which calls us together to-day, unique in the history of our institute, when all the men who have assisted me in realizing this grand intellectual work join hands, knowing that age may soon arrest my efforts, I express my confidence that the honour and learning of one and all will suffice to continue after my time and in the same spirit the task to which I have conscientiously devoted my life. I wish that this monument may afford a shelter for the labours of savants impartially, and hope that it may never minister to the vanity of any one; and when the last acclamations of this assembly, proclaiming the coming of age of a new science, shall die away behind us, the simplicity which accompanies the birth of the greatest moral forces will take up its abode here for ever.

The consecration given by you to my scientific career overwhelms me with joy, for it proves to me that I have not led by an uncertain path the toilers who have followed me, but have been able with their co-operation to increase a little the light which guides us in the progress of the dignity of humanity.

I also desire to express my gratitude to the official missions, to the delegates of scientific bodies, to the illustrious men come hither from all parts of Europe to do homage to a new branch of modern science, the power which transforms the conditions of life, the mental attitude of men, and the relations of nations. And while I experience a feeling of victory at this spectacle of an intellectual cohesion full of encouragement in the midst of the aimless agitations of the world; while I see promises of peacefulness in the more and more active participation of states in the festivals of art and science, I am moved to the bottom of my heart at seeing here the delegates of the Institute of France. For this association, the purest emanation of French genius, has for twenty years followed and supported my labours, and I regard it as the inspirer of my working career. When I let my eyes rove among the ranks of my auditors, I find everywhere some memory that appeals to my mind or my heart.

Lastly, I would testify my affectionate esteem to the group of workmen who represent the builders of this edifice. During the eleven years their task has lasted they have never disgraced themselves, no disagreement has cast a shadow over their workshop. In spite of the tempest which dashes so many brains defenceless against the wild instigations arising from the gaps in an imperfect civilization, their prudence has not given way. Therefore, to-day, in an hour of legitimate pride, I would not only recognize the merit their energy deserves, but also express the feeling we experience of the moral grandeur of the work accomplished.

Gentlemen, I open the Oceanographical Museum of Monaco in order to hand it over to the servants of scientific truth. In it they will find quiet, independence, and the emulation which fertilizes thought. When their thoughts wander from this monument over the blue waters which veil the mystery of our origin, they can sweep all round the world, coming in contact with organisms which hand down to us the story of the ages. When they skirt the flank of our mountains, or rest in their caverns, or in the midst of remains of dead generations, they can plunge into dreams called forth by the history of the Earth. And if they mount to the summits which dominate all the horizon, they will easily reach the recesses of the universe, there to lose themselves in the secret of our destiny.

THE ROYAL COMMISSION ON CANALS AND WATERWAYS.

This Commission was appointed on March 5, 1906, to inquire into the Canals and Inland Navigations of the United Kingdom and to Report on—

(1) Their present condition and financial position.

(2) The causes which have operated to prevent the carrying out of improvements by private enterprise, and whether such causes are removable by legislation.

(3) Facilities, improvements, and extensions desirable in order to complete a system of through communication by water between centres of commercial, industrial, or agricultural importance, and between such centres and the sea.

(4) The prospect of benefit to the trade of the country compatible with a reasonable return on the probable cost; and

(5) The expediency of canals being made or acquired by public bodies or trusts, and the methods by which funds for the purpose could be obtained and secured, and what should be the system of control and management of such bodies or trusts.

Four Reports have been issued, embodied in seven volumes. Vol. 7—the fourth and final Report on England, Wales, and Scotland—contains a discussion of the evidence of the 266 witnesses examined and the conclusions of the Commissioners.

Part I. is an "Historical Sketch," and contains much interesting information. The first canal constructed in the United Kingdom, as distinct from a canalized river, was the Bridgewater canal, from Worsley to Manchester, opened July 17, 1761, and the greatest part of the existing system had been completed by the end of the eighteenth century. The flourishing period for inland waterways came to an end as the railway era advanced, and the position of the canals as to total traffic has been at best stationary between the middle of the nineteenth century and the present time, while the transport business of the country has multiplied several times.

The total mileage of canals and navigations at present used in the United Kingdom is given as about 4670 miles—3639 in England and Wales, 183 in Scotland, and 848 in Ireland; 3310 are neither railway owned nor controlled, and 1360 are so owned or controlled. It is shown that the canals in this country were constructed upon no general scheme or system. As a result of this, while it is possible for a canal boat to go from London to the Mersey or from the Severn to the Humber, the line of waterways is controlled by such a multiplicity of authorities that there is an absence of uniformity in width, depth, in general conditions and in the dimensions of the locks and bridges. An obstacle to through trade therefore exists, similar to that which at one time existed through the difference of gauges in railway lines.

In Parts II. and III. the Commissioners consider the present condition and financial position, and tables are given comparing the years 1888, 1898, and 1905. It appears from these that the tonnage conveyed by those waterways of which statistics are available was, in 1888, 35,301,857 for the United Kingdom, and in 1905, 34,136,767, thus showing a practically stationary condition. It is apprehended by the Commissioners that under present circumstances capital engaged in manufacturing certain classes of goods in the Midlands may gradually migrate to the coast, or even that the process might take the form of the closing down of works. If, on the other hand, through increased cheapness in moving materials, the Midland industries can be maintained or expanded, the railway companies must also gain, as they would retain the passenger traffic and a large share of goods traffic of a certain class.

Four main routes have been selected by the Commissioners which should under any policy of improvement be treated as "great highways traversing Central England." These form what is popularly called the "Cross," and connect the Birmingham and Midland district with the estuaries of the Thames, Mersey, Severn, and Humber. After a careful review of the continental waterways and a consideration of the conditions in England as compared with those in France, Belgium, and Germany, the Commissioners conclude that it would not be practicable to follow the continental lines too closely, and that so large a standard of dimensions as that which has been adopted in Germany, North Belgium, or even on French canals would not be suitable here.

In dealing with the question of water-supply in Part X., it is of interest to note that the investigations of the Commission have shown "the necessity, if the canal system of the country is to be improved and extended in the future, of an authority which would have power to collect and tabulate information regarding the flows of rivers and streams and as to the water supplies available in districts where inland waterways now exist." The difficulties of investigation were greatly enhanced by the absence of statistical information as to the flows of rivers and streams. The Commissioners conclude that the improvement of the main routes of waterways and of the branches and feeders would be of great benefit to the trade of the country. Opinion was divided as to whether or not the traffic would give an adequate direct return on the necessary capital outlay.

"The Commissioners have realized more and more as their inquiry has proceeded, how hopeless it would be to expect anything from the waterway system of England and Wales in the future for the benefit of trade and industry if the waterways were left in their present disunited and unimproved condition."

The most urgent part of the recommendations is that a Waterway Board should be appointed, consisting of three or five Commissioners paid and giving their whole time to the work, their duty to be to review the whole situation, and on being satisfied that either the acquisition or unification or in addition the reconstruction and improvement of certain waterways would be desirable, they should propose a scheme for the sanction of Parliament, and should have power, with the approval of the Treasury, to issue stock or raise loans guaranteed by the State to obtain the capital required.

It is indicated that the work of carrying the entire scheme for improvement into effect should be gradual, each stage being preceded by a careful estimate of the cost and prospects of traffic returns. While State aid is recommended, it is added that, "It would be necessary to ascertain, as regards each successive measure of improvement which the Waterway Board take up, as to what extent assistance would be rendered by at least some of the localities and interests that would receive benefit."

The acquisition of any British waterways of importance now in the hands of railway companies is advised as an early part of the scheme. Whether the collection of information as to the flows of rivers and streams should be entrusted to the Waterway Board is recommended as "worthy of careful consideration."

The recommendations in this Report do not refer to Ireland, as a separate Report will be issued on the Irish canals and waterways. In Part XIV. the Scotch waterways are dealt with. The project for constructing a ship canal between the estuaries of the Forth and Clyde is considered. The Commissioners obtained the views of the Board of Admiralty and the Committee of Imperial Defence on this, and the conclusions of the Committee show that, while a ship canal constructed to meet the requirements of the Admiralty "would unquestionably possess some strategical value," this would not be sufficient to warrant any considerable expenditure from Government funds, or a State guarantee of interest on the total estimated cost of construction; but that some Government aid would be obtainable towards a commercial canal of the required dimensions if it followed the route through Lochs Lomond and Long.

As to the Caledonian canal, the Commissioners recommend that the Government should take into consideration the advisability of making further grants for works of improvement.

It is stated that a strong case has been made out for improved communication across the Mull of Kintyre, with only two locks at the two entrances. The Commissioners would not attempt to decide between the rival projects laid before them of the improvement of the Crinan canal and the construction of a canal at Tarbert.

Broadly speaking, the Commission favours a policy of unification and improvement, the details of which must be left to the proposed Waterway Board. The Majority Report is signed by sixteen of the nineteen Commissioners, but with reservations in five cases.

J. S. O.

SOME RECENT CHANGES IN THE COURSE OF THE TRENT.*

By BERNARD SMITH, M.A., F.G.S.

ATTENTION having been drawn, during the last two or three years, to certain changes which were said to have taken place in the course of the Trent within the historical period, I was led to consider whether other changes had been put on record, and how far they agreed with geological and other evidence. The results of my investigations are embodied in the following somewhat inadequate account of that part of the Trent between Nottingham and Gainsborough. The district most minutely described, because best known to me, lies between Newark and Dunham

* With the permission of the Director of the Geological Survey. Research Department, December 16, 1909.

Bridge 12 miles to the north, in Sheet 113, 1 inch Ordnance Survey Map; beyond these limits only one or two isolated and striking examples are mentioned.

The Ancient Trent.

In late Glacial times, waters, probably impounded by an icy barrier,* escaped over a col or wind-gap at Lincoln and deposited the gravels capping the highest hills between Newark and that city. The gap was lowered, and a second series of gravels distributed on gently inclined slopes of the solid rocks and in hollows scoured through the older gravels. Such gravels occur near Nottingham, Radcliffe, Farndon, and Newark. From the latter place they stretch to Winthorpe and Langford, and thence in a well-defined S-shaped belt to within 1½ miles of Lincoln. The waters again rapidly fell * almost to the level of the Trent valley, and then escaped by two exits: the Humber and the Lincoln gap. Gravels thus accumulated not only occupy the present valley floor, but spread widely over the ground to the east, abut against the well-marked terrace of the second series near Langford and Eagle, and sweep round the northern flank of the Doddington hills to Lincoln.

The scanty evidence at our disposal tends to show that all these deposits were formed after the retreat of the ice, for although they rest upon boulder clay at several points, they are never found beneath it.†

Again, the valley floor between Nottingham and Newark is post-Glacial, because no drift has been found beneath the river deposits.‡ The river had, however, established its present course before the close of the Pleistocene period, because the bones of extinct mammalia § have been found in the valley deposits above Nottingham. At such a time heavy floods would occur on the melting of ice and snow, and the river and its feeders would be larger and more powerful than the present stream, which cannot lift and spread gravel over its flood-plain. The stream was choked with *débris*, and compelled to split into rapidly changing branches which spread the gravels far and wide.

Since their accumulation the inequalities of surface have been partly levelled up by deposits of fine sediment brought down by the side streams.

The Trent of To-day.

The surface of the present river is at a slightly lower level than that of the latest gravels. At ordinary times it rearranges the mixed sand and gravel, depositing the sand above the gravel, and placing a layer of fine loam, derived mainly from Triassic rocks, upon the top of all. Thus the alluvial plain within the old gravel plain is built up both by lateral movement or planation, and by floods which level up the surface.

Evidence for Changes.

The conclusions arrived at as to recent changes in the river's course are based upon evidence of the following kinds:—

(1) Geological—noted on the ground.
(2) Historical and documentary.
(3) Old maps and plans.
(4) The flood-banks.
(5) Reports from living witnesses.

* Probably when the Marlstone of the Lincoln cliff was cut through.

† "The Geology of the Country around Lincoln," *Mem. Geol. Surv.* (1888), p. 145.

‡ "The Geology of the Country between Newark and Nottingham," *Mem. Geol. Surv.* (1908), p. 73.

§ *Ibid.*

Navigation and Floods.

Villages of Danish and Saxon origin are situated upon both banks of the Trent, which from very early times has been a means of communication and a highway.

The Foss dyke, west of Lincoln, follows the course of the old Carr dyke, a Roman work connecting the Lincolnshire fens with the Trent near Torksey. Gates of some kind were without doubt erected by the Romans to prevent the waters from reaching Lincoln by way of the Carr dyke, for in the past every flood must have taken this route to the sea. It is also probable that the five low gaps on the east of the Trent valley—at Marton, Torksey, Foss Dyke, Newton, and Spaldford—were embanked by the Romans;* the banks are at any rate of very ancient date. The southern, Spaldford "Wath bank" is most dangerous, because the fall from it to Lincoln is greatest. In February, 1795, it burst,† owing to a thaw following two months of frost and snow, and the flood covered 20,000 acres west of Lincoln. The bank has often been in peril when floods have inundated the Trent valley.

Domesday Book records that the water of Trent was kept so that if any should hinder the passage of boats he should make amends. Henry I. gave the Bishop of Lincoln permission to erect a bridge at Newark, "so that it may not hurt my city of Lincoln nor my borough of Nottingham."‡

Acts of Parliament relating to the navigation were passed between 1699 and 1794, and troubles about weirs arose as early as 1292. These and other instances mentioned later show that importance was attached to the control of the waters from fairly ancient times.

Changes in the Course due to Invasion of the Gravel-plain.

Changes involving more than mere straightening by cutting across a loop have in some cases been determined by the peculiar conditions of surface of the latest valley gravels between the recent alluvium and the old valley wall. These flats are traversed by a drainage system consisting of hill-streams and of becks, which often rise near the river, flow away from or parallel to it, and finally make junction downstream. Should the heads or loops of any of their shallow trenches be near a point where the river in flood is likely to overleap its bank (*e.g.* the outer curve of a meander), the conditions favour a change of course: the flood pouring into the shallow groove would be concentrated and cut away the strip of gravel between the old and new path.

Had not timely repairs been made to the bank south of Rolleston in 1905, the Trent would have accomplished this feat and swept down the course of the Rundell dyke past Rolleston and Staythorpe.

Rastall,§ quoting from an autograph of Thomas Heron, of Newark, says, "Where the main stream now runs by Kelham, there was a small brook which not being sufficient for the various purposes of the Sutton family resident there, a cut was made from the Trent to the brook which gave a turn to the whole current, . . . it then forced its way and formed that channel which is now seen. There were carriage bridges over the brook, at Kelham and Muskham, . . . and they were obliged to build bridges over the new and extended river." This probably happened previous to 1225, for tolls were then collected at Kelham bridge.‖

* J. S. Padley, 'The Fens and Floods of Mid-Lincolnshire' (1882), pp. 1, 2.

† *Ibid.*, pp. 2, 3, and Map. The effects are still visible.

‡ 'Vict. County History of Nottingham,' p. 238.

§ Rastall (William Dickinson), 'History of the Antiquities of Newark' (1805), p. 45.

‖ Nottingham Borough Records, 1225, November 17.

In 1347 (Patent Roll, 20 Edw. III.) John de Sutton of Averham and others made cuts and pulled up piles to the detriment of the Newark millers.

At Kelham the strip of recent alluvium is no wider than the river itself.

As chronicled by Dickinson and Throsby, Holme was a hamlet attached to the parish of North Muskham, until the Trent, during a high flood in A.D. 1600, separated the two places; but Saxton's map, published about 1576, shows Holme already cut off. A will of Stephen Surflett,* of the same date, leaves land for the maintenance of the water-bank at Holme; it is therefore probable that the change took place in Surflett's lifetime. The alluvium between Holme and Muskham is thrice the width of the stream (Fig. 1); but whereas the Kelham cut was nearly straight, that at Holme must have followed a winding course. Subsequent movement of the meanders would account for the greater width of the alluvial strip. Last century an old man at Holme remembered a barge sinking in the river on a spot now an orchard 100 yards from the stream.†

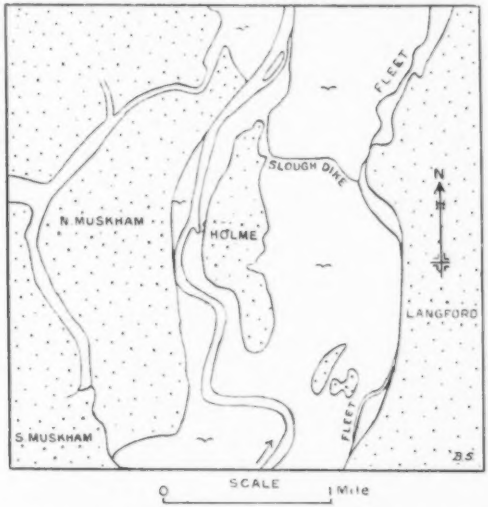


FIG. 1.—THE TRENT SEPARATING HOLME FROM NORTH MUSKHAM. THE STIPPLED AREAS ARE GRAVEL. SCALE 1 INCH = 1 MILE.

Changes on the Recent Alluvium.

The Nottingham Borough Records for 1392 give an account—after Royal Commissions in 1378 and 1383—of a "Process against the Lord of Colwick for obstructing the course of the Trent," the substance of which is, that William de Colwick, Knight, and others, have diverted the waters of Trent from its ancient course into a trench by which a portion of the said water formerly held its course, by planting obstructions. The water totally left its former course and ran to the mill in Over Colwick, where a closed "wear" was made. The former course, about

* My thanks are due to Mr. T. M. Blagg, Little Carlton; Mr. E. L. Guildford, Nottingham; Mr. A. E. Frost, Kelham; and others for suggestions and references.

† E. G. Wake, M.D., 'The History of Collingham' (1867), p. 95.

1¾ miles in length, between the vil of Adbolton and the vil of Over Colwick, was destroyed and filled up so that ships could not come to Nottingham for nine years. The former course is the Old Trent now defining parts of the boundaries of Colwick and the Borough of Nottingham.

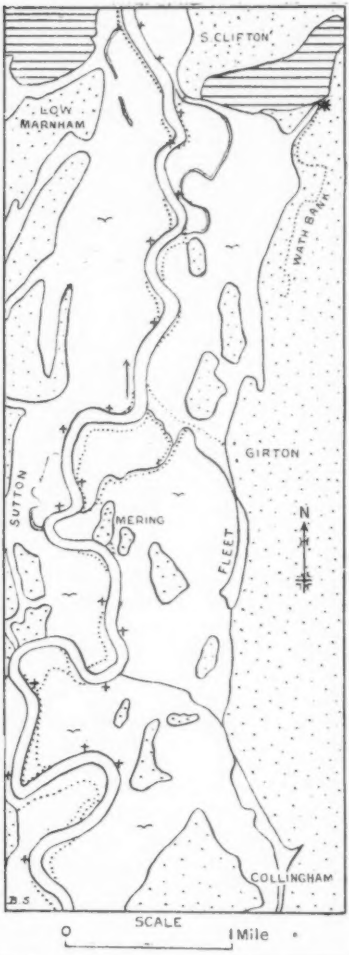


FIG. 2.—MAP OF THE TRENT VALLEY BETWEEN SOUTH COLLINGHAM AND SOUTH CLIFTON, SHOWING OLD COURSES AND THE BANKS (DOTTED) WHICH ARE NOT ACTUALLY AT THE WATER'S EDGE. CROSSES INDICATE POINTS WHERE CORRASION IS PROCEEDING; THE STAR WHERE THE BANK BURST IN 1795. SHADED AREAS ARE KEUPER MARLS; GRAVELS ARE STIPPLED. SCALE 1 INCH = 1 MILE.

Instead of passing Kelham, as at present, the Trent, or a branch of it, formerly passed Newark some 345 yards distant from the Castle and joined the Devon below the town. This Old Trent, now a mere trickle in a narrow winding valley, separates the hundred of Newark from that of Thurgarton. Above Newark an artificial cut connects the Old Trent with the Devon, which, after flowing beneath the Castle, joins the Trent at Crankley's point 1½ miles downstream. The arrangement is shown in an old map of 1558 in Brown's 'History of Newark.'

Further north the stream has, at some unrecorded * date, cut off a field from Carlton parish, and although separated from it by the river, the villagers still exercise their right of pasturing cattle thereon. This field, Carlton Holme, by its uneven surface, has the appearance of being formed by lateral movement of the river; the old flood-bank may have fixed the parish boundary.

Between Sutton on the left bank and the Meering, an island is shown on Saxton's map of 1576, and on others down to Harrison's of 1792. The eastern channel has silted up, and old meanders are visible upon the site of the island (Fig. 2).

Sutton South Holme was an island in 1834; † a part of the western stream course still exists as a long pool. The river evidently bifurcated by pouring sideways, from the outer curve of a meander, into the channel of a stream draining the alluvium. The entrance to the backwater points downstream, probably because the meander has

* E. G. Wake, M.D., 'The History of Collingham' (1867), p. 38

† Map published in 1834 by G. Sanderson, Mansfield.

moved in that direction. This also happened at Dunham island referred to later.

Across the river, and belonging to Sutton, is Smithy marsh, a pasture some 120 acres in extent. A bank, ditch, and the parish boundary on the east fix the site of the old Trent which changed its course before the date of Saxton's map.

South of Clifton hill, east of the Trent, an old meandering course, more than a mile long, cuts off a piece of ground known as "The Ropes." This old course is probably of great antiquity, because it was the boundary of four parishes: * it is

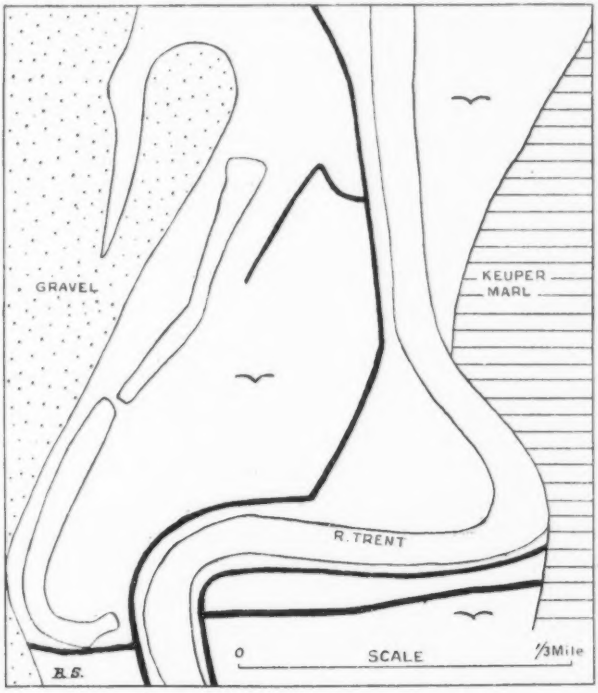


FIG. 3.—THE ISLAND SOUTH OF DUNHAM BRIDGE. THE MEANDER HAS MOVED DOWNSTREAM AND CUT OFF THE BACKWATER.

now narrowing and filling up, but maps from 1794–1834 depict it as half the width of the Trent.

On Marnham Holme, Fledborough Holme,† and under Newton Cliff, stretches of water, choked with silt and water-plants, represent other courses.

The island south of Dunham bridge, shown on maps from 1794–1834, was shaped like an inverted Welsh harp. The river invaded a neighbouring drainage-channel at the turn of a meander which has since progressed downstream, as shown by the new towpath bank (Fig. 3).

* Marnham, Girton, South Clifton, and Spaldford. It is still a parish boundary through half its course.

† Horns of red deer were found at 25 feet (C. Fox-Strangways, *Q.J.G.S.*, vol. 44, p. 158; and *Geologist*, vol. 4).

The Fleet Stream.

Between Langford and Girton there is a low westerly-facing cliff of gravel and sand, beneath which the Fleet stream flows from Winthorpe to join the Trent near Girton. The relations between the cliff and alluvial plain make it clear that the Trent has worked along different parts of it at one time or another; there are, in fact, expansions of the Fleet at Langford, Beesthorpe, and Girton, and formerly at Collingham, which must be regarded as relics of the old Trent. The most important is the Fleet mere, between Beesthorpe and Girton; once a full mile long, it is still a picturesque lake as wide as the Trent itself, and two-thirds of a mile from end to end (Fig. 2).

Movement of the Trent from East to West.

Before separating Holme and Muskham, the Trent probably followed the line of the Fleet at Langford and the Slough dike (a parish boundary), which enters the river at the Roman bridge lately discovered near Cromwell. At some previous date it flowed past North and South Collingham, where two long pools have been recently drained; and the Fleet mere is undoubtedly a part of the old river. North of Girton some low gravel islands are so closely connected as to preclude the possibility of the river having passed through them except at their northern end near the Wath Bank.

Whether the Trent flowed beneath the whole length of the gravel cliff at the same time is an open question.

Wake and others assume that the floods are efforts of the Trent to regain its old channel, now occupied by the Fleet. They point out that the hundred of Thurgarton on the west is separated from that of Newark, not by the Trent, but by the Fleet, and conclude that the Trent followed this course in King Alfred's days.

The river has certainly moved from the east to the west, and is still doing so. On its right is a well-dissected gravel plain; on its left an unbroken sheet, upon which it tends to encroach.

It first left the Wath Bank at some date before 900 A.D. (according to Wake), when the hundreds were defined; deserted the Fleet mere between the tenth and sixteenth centuries; and lastly separated Holme and Muskham. There were probably intermediate stages when the river cut through from North Collingham to Carlton Rack, and when the Kelham parish boundary was crossed.

Thus the old story is repeated. The ancient Trent flowed directly from Newark to Lincoln; then some of the waters fell away to the west to find exit by the Humber. Now the river flows in a northerly direction, but is edging to the western side of its valley—an effect probably due to freer egress through the remarkably narrow gap between the Keuper hills of Marnham and South Clifton, which would tend to shorten and straighten the course as far south as Kelham and Averham.

Lateral Movements.

Abandoned meanders and dying pools occur in such numbers that the conclusion is forced upon us that without embankments or drainage the valley would rapidly revert to a state very similar to parts of the Mississippi valley, where anastomosing channels and ponds occur in unusual numbers.*

These channels were mostly formed within the loops of meanders during the process of planation. My colleague, Mr. W. B. Wright, mapped at least twelve hollows or dry channels on one square mile near Burton Joyce. I myself have

* See Pl. 52, 'Interpretation of Topographic Maps.' Salisbury & Atwood. 1908.

frequently noted them on the large Holmes below Newark. They are now being formed at Smithy marsh, and near Collingham wharfe and Carlton ferry, where the river may in the future straighten its course as it did at Bole and Burton near Gainsborough.

The "Smug and silver Trent" was well known to Shakespeare, for Hotspur—*King Henry IV.*, Pt. I.—proposes to cut through the neck of the Burton loop or "Round." By 1790 the loop had almost closed, and in February, 1792, the Bole round was breached by the river (possibly aided by the bore or "ægir")—an event celebrated three years later by a Mr. Gurnill of Gainsborough, who published a map showing that the other loop would soon suffer the same fate (Fig. 4). White's Directory of Nottinghamshire for 1832 states that "Until 1797 the Trent here (Burton) took such a circular sweep that a boatman might have thrown his hat on shore and after sailing 2 miles have taken it up again, but in that year the stream

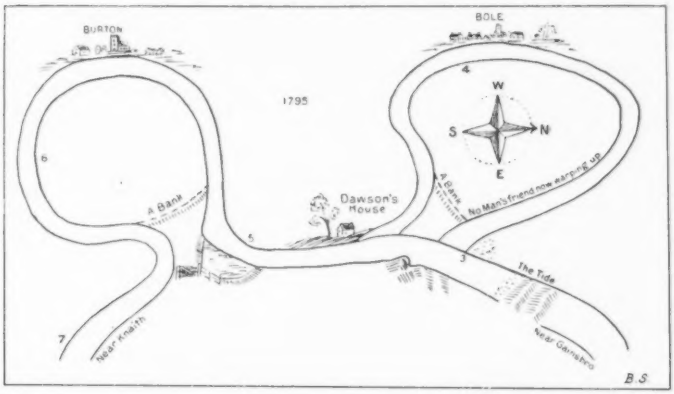


FIG. 4.—BURTON AND BOLE ROUNDS, AFTER A MAP BY MR. GURNILL, SENR. GAINSBOROUGH, 1795.

forced itself through the narrow neck of land in a straight line, in consequence of which the old winding channel was filled up and divided betwixt the counties of Nottingham and Lincoln, besides which the latter had now about one hundred acres on the west side of the course of the present river." Both rounds have recently been transferred to Nottinghamshire, and remain as swampy hollows in Burton and Bole parishes, whose boundaries they partly define (Fig. 5).

About a mile north of Newark, near the Crankleys, an old loop of the Trent forms an ox-bow lake. This loop appears as a right-angled bend in a map of 1646 (revised and published in 1725), drawn by the chief engineer of the Scottish army besieging Newark; and again in Chapman's map of 1774. In 1861 the Great Northern Railway was carried across the then well-developed loop, and to facilitate operations, the bridge was first built upon the neck of the loop, and the river diverted to a new channel cut across the neck beneath the bridge. Human remains, described by Huxley as Neolithic, as well as antlers of red deer, bones of ox and horse, were found beneath the bridge at a depth of 25 feet.* Other evidences of

* *The Geologist*, vol. 4, 1861, pp. 246, 349, 415, 495.

recent lateral movement are numerous; the example at Holme, given above, is a case in point. Roman pottery occurs in the gravels on the west bank above the Roman bridge, where the river runs straight, and a block of dressed lias stone was recently found here in excavations for a lock, at least 25 feet from the bank.

Again in A.D. 1649 * a field—situated beyond the Trent, but in Collingham parish—once of 35 acres, had been reduced to 8 acres by encroachment.

The Flood-banks.

The most striking evidence of planation is furnished by the flood-banks, although the age of many of them is obscure. Some are as old as, or older than, the parish boundaries they define, others are comparatively recent.

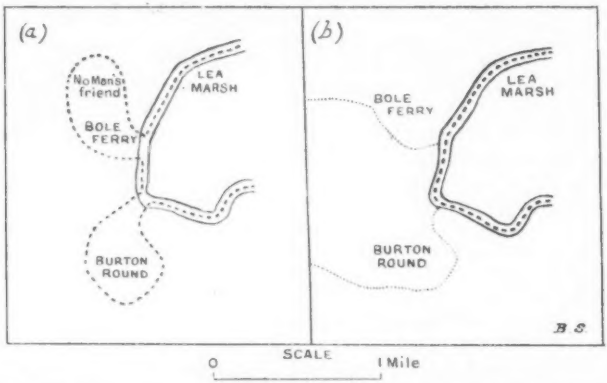


FIG. 5.—THE TRENT AND THE ABANDONED ROUNDS WHICH HAVE BEEN TRANSFERRED FROM LINCOLNSHIRE TO NOTTINGHAMSHIRE. (*a*) ORDNANCE MAP OF 1824. (*b*) ORDNANCE MAP OF 1898. SCALE 1 INCH = 1 MILE.

The Trent is supposed to be a tamed river. Its banks are fortified by flood-banks, piles, stones, cement, and even sunken barges; yet it still persists in meandering. As fast as it undermines the flood-bank, the latter is repaired from the outside, hence the river, so to speak, pushes the outer flood-bank before it where vigorously corrading, but leaves the inner bank isolated by deposit of sediment. A second inner bank then becomes necessary to carry the towpath. †

These deserted banks and new towpath-banks between Collingham and S. Clifton have been plotted on the map (Fig. 2), which shows clearly the movement of the meanders.

Since the Dunham island was formed, the meander, in moving downstream, has deposited at least 15 acres of sediment.

Interference with the River.

If the natural swing of the river is tampered with, it retaliates by readjusting its course below the point of interference. A single case will point the moral.

* Wake, 'History of Collingham,' p. 38.

† According to Mr. F. Rayner, of the Trent Navigation Company, the towpath was made somewhere about 1783.

A breakwater was built upon the eastern bank above Kelham bridge about nine years ago to protect the Newark-Kelham road. The river then attacked the road a little further downstream. Repairs were made last year, and the bank was protected by stakes, cement, and sunken barges, with the result that the main flood is thrown into the eastern span of the bridge, and is rapidly clearing away a large stretch of gravel and loam which had accumulated below. The opposite bank has entirely altered; shallows appear where none were before, and deep holes take the place of shoals; the movement is in fact felt a great way downstream.

The following is a list of some of the maps showing the Trent in Nottinghamshire: 1576, Saxton; 1646, chief engineer Scots army, copied and revised by S. Buck, 1725; 1670, Blome; 1676, Thoroton; 1695, Morden; 1727, Moll's English Atlas; 1744, J. Jefferys, Junr.; 1744, J. Chapman (1st Edit.); 1777, Emm. Brown; 1792, J. Harrison; 1794, Cary; between 1792 and 1797, J. Chapman (2nd Edit.); 1795, Gurnill (Burton and Bole rounds); 1801, C. Smith; 1813, Arrowsmith; 1824, Ordnance Survey; 1834, Saunderson; recent Ordnance maps.

Mr. G. W. Lamplugh: Mr. Smith has shown very clearly that changes have constantly taken place throughout historical times in the course of the Trent; but to any one who knows the structural conditions and past history of the valley, it is really surprising that the changes of the river have not been even greater. Indeed, that the stream should have maintained so nearly its present course during historic times is good evidence for the interference of man from an early period. The river flows along a wide valley with a flat floor built up from the overburden of material brought down by ancient floods, and the present stream is inadequate to remove this material. Upon this flat floor the Trent, under natural conditions, would be likely to shift its branching channels every season, or even many times in a season, as we know to be the habit of uncultured streams of this type in the unsettled parts of the world; but it is not allowed to do so. We see plenty of evidence that it once had this habit, in examining the old alluvial deposits of the Trent. Man came, and found it inconvenient to have an untamed river, so he set about to tame it; and now it affords a good example of the effect of civilization upon a stream.

The travelling downstream of the meanders is of course what takes place in every river of this type; and it would be very interesting if the rate of travel could be definitely ascertained. But I understand that there is doubt in some cases whether the old flood-banks were erected originally close to the river-brink, and where this doubt exists it may not be quite safe to calculate from the present relative position of the bank. Still, as to the truth of the principle on which the argument is based there can be no doubt.

Mr. W. Whitaker: I know very little of this particular piece of country, but some of the points that Mr. Smith made might be applied to other rivers, as to the Thames. A parish-boundary sometimes crossed the river, and the county-boundary did not. This gave rise to an important law case between Middlesex and Surrey. There was another point which interested me, the gradual swaying of the river from one side of its valley to the other. We have a very remarkable case of that in one of the notable Thames tributaries, the Lea. That river has gone from west to east, and apparently it has done this far longer than in the case mentioned in the paper, because at present the river has gone so far to the east that it has cut off nearly all signs of presence on that side of the valley at a much earlier time. All the gravel-flats are on the western side, and that looks like a tolerably steady move from one side to the other. Mr. Smith has included among his evidence historical and documentary matters; I think that he will often find that particular class of evidence not worth much; it may sometimes be very misleading. In the legal

case spoken of, the judge said he would not accept a single map or document as evidence, and I think he saved himself and the jury a great deal of trouble. I hope that Mr. Smith will exercise great judgment as to how he deals with this sort of evidence. He may get in places very good historical and documentary evidence, but you must always be ready to put a query after it. It is to be hoped that this inquiry will be extended lower down the river. It is a big thing, and no doubt Mr. Smith has found it convenient to take a piece first. I believe that there is in this country a great deal to be done in this tracing out of the course of even some of our best-known rivers, such as the Thames, that we may get much information from careful work of the sort Mr. Smith has given us.

Prof. P. F. KENDALL: My interests lie rather in the earlier than in the later phases of the history of the Trent valley, but as a student of the Humber drainage I cannot but be interested in Mr. Smith's paper. The evidence adduced of a general swing to the westward and the explanation offered seemed to be very satisfactory. It was an attempt on the part of the river to shorten a part of its course. Taken with the case of the Lea mentioned by Mr. Whitaker, it pointed to the necessity for caution in accepting the assertion frequently made in geological and geographical text-books that north-and-south-flowing rivers, when uncontrolled, tend to swing to the right under the influence of the Earth's rotation. Here are two rivers, one flowing to the north and the other to the south, swinging to the left in spite of attempts to control their courses. Mr. Smith has shown that there are limits to a river's forbearance, and that when endeavours are made to control its course at one place it promptly reasserts its determination to obey its own natural tendency.

There are one or two points in the early part of Mr. Smith's paper that interested me very much, though I am afraid they do not belong to the main subject-matter of his paper—his allusions to the successive stages of the deepening of the Trent valley, indicated by the terraces, and his suggestion that these changes took place before the close of the Pleistocene period. I am inclined to think, by the evidence afforded by the Trent above Nottingham, that these changes must have taken place in the very early part of the Pleistocene period. The remains in one of these terraces included hippopotamus and rhinoceros. Now, the hippopotamus is a distinctly early element in our Pleistocene fauna, and if I remember rightly, the deposits in which they occur are very little above the Trent level, and I should therefore be inclined to place the high-level deposits at a yet earlier stage. Another point is the Lincoln gap. The level of the rock floor in the Lincoln gap is 23 feet below Ordnance datum. I should like to know how that would be explained by Mr. Smith's study. There is a much larger question that I hoped would have come within the scope of the paper—the strange discrepancy between the very early history of the upper and that of the lower Trent. Streams joining the Trent drainage below the furthest point mentioned by Mr. Smith, flow upon a deeply eroded landscape; a landscape that lies, in one case, 170 feet below Ordnance datum (at Barnby Dun near Doncaster). And that is not an isolated observation. In the upper part of the Trent valley no such deep trough has been discovered, and it is a very difficult problem to decide why there should be this striking discrepancy between this upper and lower course. I would suggest that there has been a warping that has brought up the upper course of the Trent, that has raised it, concurrently with the lowering of the lower course.

Dr. STRAHAN: The remarks made by Mr. Whitaker on the Thames forestall an observation I had in my mind at the time. It is a fact that at Goring a bit of Oxfordshire has, so to speak, travelled over into Berkshire; I know of no historical record of how the river changed its channel, but that it has done so

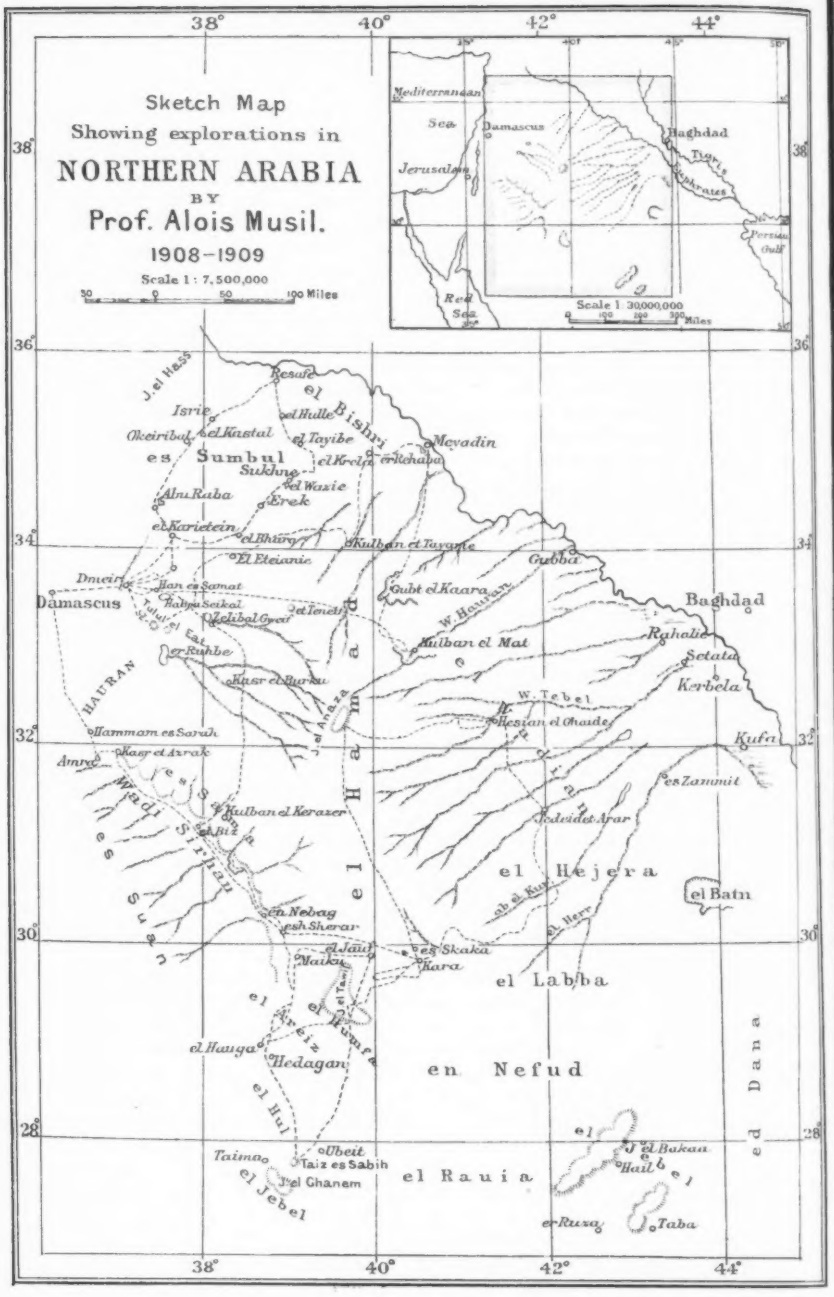
can be seen by comparing the position of the county boundary with that of the present main stream on the 6-inch Ordnance map. Mr. Smith's account of the struggles of the Trent to expand its valley has proved so interesting that I should like to see this line of research followed up in the case of other rivers, and a comparison made between rivers of different character as regards the work they are doing in altering their courses and shaping their valleys.

Mr. B. Smith: With regard to the remarks of Mr. Whitaker about documentary evidence, I know only too well that there is not too much reliance to be placed upon it, and have therefore only dealt in detail with those parts of the valley with which I am well acquainted. In reply to a question by Prof. Kendal as to the depth of the rock floor in the Lincoln gap; I do not think there is any difficulty about it. Although the surface of the latest valley gravels of the Trent is slightly higher than the surface of the present alluvium, their base is considerably below the base of the alluvium. At the very narrow gap near Clifton these latest gravels are below Ordnance datum. The fall from the Spaldford bank to Lincoln is considerable, so that it is not surprising to find the rock floor of the Lincoln gap 23 feet below Ordnance datum. There is no evidence in this area as to the warping of the lower course of the river; the fall in each set of gravels between Newark and Lincoln seems to be much the same throughout. In conclusion, I must thank the members of the department for the very kind way in which they have received this paper.

MUSIL'S EXPLORATIONS IN NORTHERN ARABIA, 1908-9.*

By his last journey—a toilsome and dangerous one—Alois Musil has removed from our maps the blank space which covered the whole large triangle between Arabia Petræa and Syria on the one hand, and Mesopotamia on the other. Leaving Vienna in the beginning of June, 1908, he arrived at Damascus on the 19th. Thence after long negotiations he succeeded in getting into communication with the powerful Sheikh of Northern Arabia, Nuri ebn Shalân. Then with his companion, Sergeant-Major Thomasberger, of the Military Geographical Institute of Vienna, three servants, and nineteen camels, he made his way in the middle of September to the camp of the sheikh, whose travelling companion he then became. Thenceforth he either marched with the sheikh or made lengthy excursions of his own from the camp. First and foremost, he measured out a base to the south-east of Dmeir, some 75 miles east of Damascus. Next, on October 11, he set off with five camels to the steppe regions in the north-east, and, passing hot springs, remains of Roman military stations, and the ruined town of Isrie, arrived at Resafe, 12 miles from the Euphrates. The ruins of churches and palaces in Resafe, with their inscriptions in Greek, Aramaic, and Arabic, proved of high interest for the history of art. This place marked the most northerly point of Musil's journey. Thence directing his course, first to the south-east and then to the south-west, he returned to the same spot by another way on November 2. During three more excursions of a like kind, but more extensive, the explorer made a plane-table survey of the whole region. The last excursion lasted from the end of March to the middle of April, 1909. In the intervals between these expeditions, he undertook shorter survey trips, or, proceeding further with the sheikh's camp, secured ethnographic records. It sometimes happened that, returning from an excursion of his own, he would be a whole week in tracing his way back to the camp.

* Communicated by Dr. Karl Peucker.


Sketch Map
Showing explorations in
NORTHERN ARABIA
BY
Prof. Alois Musil.
1908–1909
Scale 1: 7,500,000
50 0 50 100 Miles
Mediterranean Sea
Damascus
Jerusalem
Baghdad
Tigris
Euphrates
Persian Gulf
Red Sea
Scale 1: 30,000,000
100 0 100 200 300 Miles
38°
40°
42°
44°
36°
34°
32°
30°
28°
Jel Hass
Resafe
el Bishri
Isrie
el Hulle
el Kastal
el Tayibe
Meyadin
Okeiribul
es Sumbul
Sukhne
el Kreiz
er Rehaba
el Wazie
Alnu Ruba
Erek
el Karietein
el Bhiry
Kulban et Tayarie
Gubba
El Eteianie
Dmeir
Han es Samat
Damascus
Tulul esh Shak
Talya Seikal
Telul el Ethel East
Telul el Ethel West
Telul el Ethel Great
el Ienezi
Gubt el Kaara
W. Hauran
Baghdad
Kulban el Mat
Rahalie
Setata
Kerbela
er Ruhbe
Kasr el Burku
W. Tebel
Hammam es Sarab
Kesian el Ghaide
Kufa
Amra
Kasr el Azrak
es Zammit
Wadi es Sirhan
Kulban el Kerazer
el Biz
Jedeidet Arar
el Hejera
el Batn
ch Nebag
esh Sherar
el Jauf
es Skaka
Kara
el Labba
el Hamad
el Hueiza
el Humra
el Huiga
Hedagan
en Nefud
ed Dana
el Hul
Taimo
Ubeit
Taiz es Sabih
el Ghanem
el Jebel
el Rauia
el Bakaa
Hail
er Ruza
Taba

These trips, it should be noted, were all carried out under incessant alarm from robber bands or hostile tribes. On his second excursion, which was directed eastwards, Musil was stabbed in the back by a lance and in the breast by a knife, while with his attendants he was stripped of everything down to his shirt. It was only his familiarity with language and manners, and the friendly relations he had established on former journeys, that got him out of this and similar awkward predicaments. He suffered also at the hands of thievish guides, whilst even worse difficulties were caused by the climate and by the badness of the drinking-water, which more than once laid him on a bed of sickness. He passed nights in the open when the temperature varied from 8°·5 to 23° Fahr., and these would be followed by days with an air-temperature of 115° Fahr. Early on December 10, as told by him in a preliminary report to the Vienna Academy of Sciences, he had difficulty in adjusting his headcloth and blanket, so hard were they frozen, while his men hardly dared take hold of the water-bottles for fear of their breaking. After sunrise they warmed them by the fire; for to have kindled a fire earlier might have exposed the party to attack. On the third excursion, which, starting in the south-west part of the region under examination, proceeded southwards, it was with great difficulty that he found a guide. Nobody was willing to accompany him on these "Death paths" which, following on a ride through the desolate black desert of el-Bseita, led into the defiles of the westerly arm of the sandy desert of Nefud. On this excursion Musil pushed as far as the most southerly point of Jebel el Ghanem (27° 50′ N.), where lies the old Nabatæan Necropolis of el-Maiyene. The fourth excursion led him to the eastern and central parts. There, in the hot parched land of el-Hejera, further march was rendered possible only by carrying water in a linen waterproof cover tied to two saddle-bags and carefully guarded by Musil himself. Water-bottles were inadequate to the purpose. Here, in the mountainous land round Jebel Anaza, a peak renowned in fable, they suffered much from cold snowdrifts. On the watershed to the south of Anaza, there is in the Hamad next to no valley-formation, and, throughout an area 220 miles long by 250 miles broad, there was nowhere a single spring nor any standing water.

On April 12 Musil crossed what he describes as the dreadful spurs of the Harra, looking like fortifications and overtopped by extinct craters. May saw him again with the sheikh in the west, engaged mostly in ethnographic labours. In the middle of June he again visited, for the study of its inscriptions, the Khalif's castle of Amra, made known by him on a former journey. On the 19th, with his caravan he bade good-bye to Sheikh Nuri, and by the middle of July the explorer was once more in Vienna. The results of his travels are to be gathered up in the following separate publications, which will contain much matter of geographical interest:—

1. Additions to the map of Arabia Petræa in the north-east and south-east.

2. Map of Northern Arabia, embracing the region from 37° to 44° E. long. and from 36° to 27° N. lat. This will extend to the Euphrates.

3. Topographical report with exact description of the whole area explored, accompanied by many plans, sketches, and photographs.

4. Ethnographical report including an enumeration of all the nomads who have their camping-grounds in Northern Arabia, as well as an ethnographic description of the one remaining representative of the old Arab stock, the tribe of the Rwala.

5–8. Reports on natural history, inscriptions, linguistics, and other subjects.

REVIEWS.

EUROPE.

France.

'Régions et Pays de France,' Joseph Fèvre and Henri Hauser. Paris: Félix Alcan. 1909. 7 *francs.*

The student of French Geography is fortunate in the possession of a series of monographs, by specialists, issued in recent years, on various well-defined areas or districts in France. These studies vary greatly in length and in the importance assigned to different aspects of the subject, though the broad regional treatment is of much the same character throughout. So there is evidently room for a volume like the present, which combines and systematizes the conclusions of the specialists on a definite plan and within reasonable space. The book shows both the advantage and the defects of such a compilation. It is admirable as a guide to the geography of France in general, and is far from being superficial, since the authors had a wealth of material from which to draw. But the application of a uniform system to a great variety of regions does not permit of the due differentiation of the factors in geography which have a greater or less value according to the character of the particular area under discussion. Uniformity is gained only by the sacrifice of due proportion. Moreover, the treatment is necessarily less satisfactory for those districts, notably in the south and part of the centre, where less specialized material is available. None the less, the book is of great value as a guide to recent geographical work in France, and should be particularly useful to the teacher; much specialized work will be needed before England can be treated in the same way and with equal thoroughness. Its value is enhanced by the bibliographies at the end of each section, including references to maps and illustrations as well as texts. In one point the map references are open to criticism. The 1 : 1,000,000 geological map is given as the standard throughout; but it is impossible to verify many of the conclusions in the text from that map. In fact, for some purposes, even the 1 : 500,000 map is insufficient in scale. Illustrations and diagrams are abundant, clear and to the point. A. J. S.

'Erosion of the Coast and its Prevention.' By F. W. S. Stanton. (London: St. Bride's Press. *N.d.* Pp. 68. *Plans.*) A concise hand-book to a subject which has lately attracted more than passing attention through the labours of a Royal Commission. The excellent diagrams have suffered the common fatality of over-reduction.

'Switzerland of the Swiss. By F. Webb. (London: Pitman. 1909. Pp. x., 254. *Illustrations.* 6s.) The title is presumably intended to convey that this volume deals, not with the narrow interests of the tourist, but with Switzerland as a State. The people, their industries, art, education, religion, and government are the principal topics of a useful work of reference.

'Wanderings in the Roman Campagna.' By Rodolfo Lanciani. (London: Constable. 1909. Pp. xiii., 378. *Map and Illustrations.* 21s.) A delightful volume by an author full of enthusiasm for all the interests of the Campagna, from its antiquities to its biology. But as those who know his work will expect, the antiquarian is his principal interest, and, as a geographical study, the contrast between the Campagna of the Empire and that of to-day is valuable. At the cost of great weight, the volume is beautifully illustrated.

'The Pyrenees.' By H. Belloc. (London: Methuen. 1908. Pp. viii., 340. *Illustrations and Maps.* 7s. 6d. *net.*) Mr. Belloc has written an excellent

practical guide for those who wish to climb in the Pyrenees. He has not sought to write an ordinary guide-book, but to set down what cannot be found in such books—the things which he himself only learned slowly during several journeys and after much reading, and which he would like to have been told before he first set out. Apart from detailed descriptions of several districts, the volume contains, among other useful information of a general character, two illuminating introductory chapters on the physical nature and political character of the Pyrenees. The author reveals himself as an artist in a large number of sketches of varying value, while the rough but practical sketch-maps which abound through the book, will be regarded as one of its most useful features by those who venture among the Pyrenees.

ASIA.

Asia Minor.

'The Thousand and One Churches.' By Sir W. M. Ramsay & Miss Gertrude L. Bell. Illustrated with photographs and plans. Pp. xiv.–580. Hodder & Stoughton. 1909. 20*s. net.*

The title of this book, which refers to the ruins of Bir-Bir-Kilisse in ancient Lycaonia—actually the ruins of not more than fifty early churches—does not promise much geographical information; but, nevertheless, Sir William Ramsay's introductory chapter on the site and its surroundings treats of questions of interest to readers of this *Journal*. The chief of these is the hydrography of the Kara Dagh group of mountains. He brings out clearly the contrast between its condition in antiquity when adequate measures were taken for storing water, and its condition now that the old works have been allowed to decay. What he tells about the Kara Dagh and also about the irrigation system of the Konia plain (now in process of restoration) shows that we need not presuppose any serious meteorological change to account for the altered state of this region. It was fertile and well populated in antiquity, simply because extensive and well maintained works of engineering science existed then. Incidentally both Sir W. Ramsay and Miss Bell show further that the uppermost mountain levels, now generally deserted and wild, were once the resort of men even in very remote times, and in some cases were permanently inhabited. In the last chapter Sir William Ramsay discusses once more the problem of ancient topography which centres round the name and coins of Barata. The intermediate chapters are from Miss Bell's pen, and deal with the architectural features of the Bir-Bir-Kilisse churches in particular and of Anatolian and Syrian churches in general, whose construction falls between the fourth and eighth centuries; but the large question, to whose solution they make a notable contribution—the question raised by Strzygowski in his *Orient oder Rom*—is not without geographical bearing, since on its solution depend to some extent our ideas of the character and relations of the near Eastern peoples during a large part of classical antiquity. Was the influence of West or of East most strong in Anatolia in Hellenistic, Roman and Byzantine times? Where were the fountain heads of those influences and by what routes did they pass? All interested in these questions will find this finely illustrated book well worth study.

D. G. H.

Ceylon.

'Ancient Ceylon: an Account of the Aborigines and of Part of the Early Civilisation.' By H. Parker. London: Luzac & Co. 25*s. net.*

This admirable record of much minute research, made by one possessing the special qualifications attached to the position of an engineer officer of the Irrigation

Department, Ceylon, has many merits. It is divided into three main parts: I. The Aborigines; II. Structural Works; III. Arts, Implements, and Games; with a chapter on the Origin and Signification of the Cross and Swastika.

The aborigines, like those of many other countries, were described by the earliest immigrants as Rākshasas (demons), Nāgas (nondescript beings with cobras' heads behind their own), and are probably now represented by the Vaeddas and Wanniyas. The immigrants to Northern Ceylon are naturally to be expected from Southern India, and it is probable they were furnished by the Nāyars or Nairs of Malabar. Though there is no direct proof of such immigration, there is, besides its geographical probability, evidence in the existence among the Kandian Sinhalese of features resembling those of the Indian Nāyars.

The Yakkhas or Vaeddas are mentioned in the early Sinhalese histories, and it is recorded, in the Mahavansa we believe, that Pandukābhaya, the nephew of the king, with their assistance, defeated and killed his uncle and reigned at Anurādhapura, where he established his Vaedda allies on three sides of the city. This happened about 308 B.C., and he reigned to about 275 B.C. His character is that of a wise and impartial ruler, who, besides beautifying his capital, promoted and encouraged irrigation works on a great scale; these mainly took the form of holding up vast volumes of water by means of embankments placed across the lines of drainage. The modern Vaeddas are great hunters; they are subdivided into coast Vaeddas, village Vaeddas, and forest Vaeddas. Their mode of life, their food, weapons, and hunting are all carefully described; the author remarks on their amazing power of passing through thick jungle like shadows so quietly as to be able to approach all animals except the pea-fowl and kill or wound them before they are aware of the presence of the hunter. They have no fear of elephants, bears, buffaloes, or other beast the forest contains, whilst the leopard is said not to attack them.

As may be imagined from the author's professional training, Part II. on Structural Works is of special interest. It deals with an examination of bricks in order by their measurements to fix approximately the dates of the chief buildings, and goes on to describe the buildings and ruins themselves, the lost cities, and the earliest irrigation works. Finally, Part III. treats of inscriptions, coins, weapons, and tools, and games indoor and out.

The chapter on the Cross and Swastika well repays attentive perusal; the development of the latter from the former has led the author to a solution which, whether accepted in its entirety or not, provides at least a possible reason. The decision as to whether it is adequate is left to others.

There are fully 700 pages in the book, and 275 illustrations and plates.

W. BROADFOOT.

NORTHERN CHINA.

'The Great Wall of China.' By W. E. Geil. London: Murray, 1909. *Map and Illustrations. Price* 21*s. net.*

In spite of imperfections, this work, as a record of exploration, may fairly claim to be unique. No previous traveller seems to have ever contemplated or attempted to examine this astounding structure from end to end, much less carried such a project into effect. In fact, the task of thoroughly exploring the Great Wall still awaits fulfilment, for its loops, supplementary branches, and older and derelict sections are so numerous that extensive examination would be a far more lengthy and tedious business than the journey recorded in the present work. Dr. Geil is somewhat obscure as to his exact line of route, and his map is most unsatisfying, from a geographical point of view. But the numerous photographs

of the Wall reproduced in the book before us, though reduced in scale and size, are undeniable evidence of the reality of this "cross-country" journey, and of the remarkable eccentricities and varieties of design that in the course of twenty centuries have crept into this wonder of the world. For, be it understood, there is nothing like the uniformity in the alignment of this great rampart that one might infer from Prof. von Mollendorf's rather theoretical brochure on the subject. Having ourselves explored part of the Wall, we can testify that, so far as the easternmost section is concerned, the conformation of the structure varies according to the nature of the ground, and this would appear to be its pervading characteristic throughout, so far as Dr. Geil's photographs enable one to judge. The author landed at Ching-wang-tao, the well-known harbour on the Gulf of Pechili, and thence followed the Wall westward from Shan-hai-kwan, past the Mule horse-pass and the Ming tombs, along the Inner Wall to where it rejoins the northern loop on the borders of Shansi. Thence, proceeding in the main westwards, through the southern Ordos country and Kansu. The chief halting-places were Ning-hsia, Chun-wei, Lanchou-fu, Liang-chou-fu, Kanchou, Suchou, and Kia-yü-kwan, the famous western gate on the verge of the Central Asian desert. A *détour* to Sining enabled the author to bring back some valuable information as to a section of the Wall west of that town and hitherto practically unknown to European writers. Mr. H. F. Ridley, the well-known missionary resident at Sining, has furnished Dr. Geil with a map of this rediscovered wall, and curiously enough it seems to bear out the testimony of the old monk Grueber (see Astley's 'Collection of Voyages'), who makes special mention of "a vast wall" running continuously from Sining to Suchou. The photographs of this part of the journey are particularly attractive, mainly owing to the remote and unfrequented character of Western Kansu, while special interest attaches to the illustrations of Kia-yü-kwan, where the Wall comes to its distant western end. On the whole, we may be permitted to wish that the author had given us rather less Chinese history and legendary lore and rather more geography. He certainly appears to have penetrated through some particularly interesting tracts of North-Western China, but the absence of a methodically written narrative, the mixing up of incidents of travel with the diaries and translations of his followers, and the difficulty of connecting the numerous excellent photographs with the very inadequate sketch-map supplied, all help to detract from the merit of a work which might without much trouble have been made of greater scientific value.

East and Central Sumatra.

'Auf neuen Wegen durch Sumatra. Forschungsreisen in Ost- und Zentral-Sumatra, 1907.' Von Max Moszkowski. Berlin: Dietrich Reimer (Ernst Vohsen). 1909. Pp. 328. *Price, bound*, 14*m*.

The author travelled in the Sultanate of Siak in east Sumatra and in the Rokan states, on the western side of the Sultanate. He paid great attention to the ethnography of the tribes inhabiting these countries—the Tapungs, Akits, and Sakais, and gives numerous drawings of Malay houses, oil- and sugar-presses, baskets, fishing implements, etc., of the natives. Perhaps the most interesting information is that on the Sakais, one of the most primitive races in the world. As far as M. Moszkowski could ascertain, they have no religious ideas of their own, even the superstitions now prevalent among them being borrowed from the Malays, as well as their tools and implements, except the most primitive. In some of their customs they differ from their brethren in the Malay peninsula. M. Moszkowski is a biologist, and he made collections of birds and animals, and also of some botanical

specimens, lists of which are appended. The illustrations are numerous and interesting.

'Travel and Sport in Turkestan.' By Captain J. N. Price Wood. (London: Chapman & Hall. 1910 [1909]. 15*s. net.*) A pleasantly written record of travel and shooting. The author started from Kashmir, and was fortunate enough to secure permission to go by the Gilgit road and the Hunza valley, emerging into the Taghdumbash Pamir and Turkestan by the Killik pass. The path which descends from the pass leads into the Karachukur valley, a wedge of Chinese territory driven in between Russia and India, and actually meeting a similar tongue of Afghan territory, which approaches from the west. It is thus a case of where four instead of three states meet. *Ovis poli* was here secured, as well as ibex, wapiti, bear, and other big game in the Tian-shan valleys, which were the author's main objective. It is interesting to read that the telegraph is making progress in Turkestan, and that Kashgar is now actually in direct connection with Peking. Captain Price Wood's return home lay through Russian territory.

'L'Empire Japonais.' By J. Dautremer. (Paris: Guilmoto. 1910. Pp. 308. *Map and Illustrations.* 6 *frs.*) A close study of the economic and administrative conditions of Japan. The geographical introduction is somewhat perfunctory and the usual absence of an index goes far to destroy the value of the book as a work of reference.

'L'Ile de Java sous la domination française.' By O. J. A. Collet. (Brussels: Falk. 1910. Pp. xiii., 558. *Plans and Illustrations.* 10 *frs.*) This book deals with a subject on which works of easy reference are rare—the history of the Malay Archipelago at the time when French interests were prominent there, and came into conflict with those of Holland and England. Military operations are dealt with at length, and illustrated with plans. The book is simply written and replete with detail, and, being well indexed and provided with a full analysis, is easy to consult.

'Dans les Marches Tibétaines.' By Jacques Bacot. (Paris: Plon. 1909. Pp. iii., 216. *Map and Illustrations.* 3 *fr.* 50.) M. Bacot travelled in 1907 in the parts of Tibet which lie to the north-west of Yunnan, about the lower part of the Mekong headwaters. He adds to our knowledge of this territory a number of vivid impressions of the land and of the people, with many of whom he established the most friendly relations. The French language always seems to enhance the pleasure of reading a book of this sort.

'Through the Malay Archipelago.' By Emily Richings. (London: Henry J. Drane. 1909. Pp. 251. 6*s.*) This "slight volume" has been "written as a *compagnon de voyage* to the wanderer who adds a cruise in the Archipelago to his Eastern itinerary." It contains a description by a lady traveller of a tour through the Dutch East Indies, and embodies a good deal of information of a tourist character about a part of the world which has not figured to any great extent in English travel literature. It is, however, an irritating volume, spoiled by excessive word-painting, and supplied with neither illustrations nor maps.

AFRICA.

Exploration and Sport in Eastern Equatorial Africa.

'In Afrikas Wildkammern als Forscher und Jäger.' Von Dr. A. Berger. Berlin: Paul Parey. 1910.

Dr. Berger, accompanied by Captains J. Roth and Kurt von Donner, has almost out-Schillingsed Schillings (who, by the by, seems to have settled down into the placid position of a professor, and who contributes a preface to the work under review) in his splendid photographs of wild life in the most wonderful part of

Eastern Equatorial Africa. Whether it be landscapes, wild beasts, or wild peoples, his pictures attain, perhaps, the highest rank in any as yet produced. His motto has been, he tells us, "Truth in word and picture." The photographs possess the rare distinction of being completely untouched, and there is not too much about them of the flashlight and the clever trick—those cords, traps, tents, and camera disguises which occasionally obtrude themselves into the modern surprise picture of beast or bird.

The three travellers, whose experiences are recorded in a text which is as interesting as its photographs, entered British East Africa by the Mombasa-Uganda railway, and travelled thence and by caravan to the Guaso Nyiro, Lake Baringo, North Elgon, the Ripon falls of the Nile, Kampala and Entebbe, Lake Albert, the Mountain Nile, Gondokoro and Egypt. They also made an excursion in the direction of Mount Kenya. Although a great many acknowledgments of indebtedness for kindness, etc., appear in the preface, these are all directed to Germans in Germany and London, and nothing is said about the British officials who seem to have been both kind and helpful to this expedition.

But, judging from some of the photographs and statements, these German gentlemen seem to have been unacquainted with the English language, or, at any rate, unable to interpret and apply the published Game Regulations and the notifications about Game Reserves. Or, it may be, that, as occasionally happens, they were accorded special privileges. At any rate, though the fast disappearing white-mantled Colobus monkeys are supposed to be very strictly protected, there is a photograph on p. 244 of a great heap of slain "Colobus Affen," and that, too, in what I believe is still a Game Reserve. But, after all, as the British themselves honour these laws more in the breach than by observance, there is no need to grudge a similar laxity of control to German travellers who make such splendid use of their opportunities as is the case with the writer of this book and his friends (some of whom, though not actually his companions on this particular journey, have lent him further photographs).

This book will be a feast of delight to all who are interested in the fauna and peoples of Africa. It should certainly be translated into English, because it is valuable for its text as well as its illustrations, illustrations of a fauna which is disappearing so rapidly under the raids of "sportsmen" that its more interesting features will probably have ceased to exist in another twenty years.

When the present writer in his work on Uganda ventured to make some remarks from personal observation of the difficulty of descrying giraffes amongst the acacia trees, and still more amid those vestiges of burnt forests which were the result of bush fires, his statements as to this mimicry were somewhat disputed by Mr. Selous. But it is clear there is this resemblance between gaunt tree trunks and immobile giraffes: witness the illustrations opposite pp. 142 and 144. For sheer beauty, attention might be drawn to the photographs (opposite pp. 214 and 120) of flamingoes on Lake Hannington. The travellers killed several white rhinoceroses in the Lado enclave, and of these magnificent photographs are given. They believe themselves to have discovered a new species of hyæna in the Elgeyo Gorge, but it is doubtful whether this is more than a mere variation of the *Crocuta* type.

H. H. Johnston.

'The Land of the Golden Trade.' By John Lang. (London: Jack. 1910. Pp. ix., 315. *Maps and Illustrations.* 6s.) This volume, in the now well-known 'Romance of Empire' series, may be rather florid in style for the taste of some readers, as regards both the writing and the coloured illustrations. But it shows a proper appreciation not only of romance but of perspective in the chequered

history of the white man in connection with the west coast of tropical Africa from the earliest times. This book will maintain the reputation of the series as giving really good value at its price, and filling the purpose it claims to fill.

'Guide to Egypt and the Sûdân.' (Sixth Edition. London: Macmillan. 1909. Pp. xvii., 177. *Maps and Plans.* 5*s.*) Revision in every necessary direction has been applied to the new edition of this favourite guide, which is well printed and conveniently small, while the maps are very fair.

'Labour in Portuguese West Africa.' By W. A. Cadbury. (London: Routledge. 1910. Pp. xii., 187. *Map.* 2*s.* 6*d.*) The interest of the author in the subject with which this book deals has been recently brought before the public, which should therefore welcome his views. We learn that the book has been translated and will be widely distributed in Portugal. A complete survey of the conditions of native labour in Angola and the Portuguese islands is given.

'Journal of our Mission to Fez.' By the Military Attaché (Colonel Count Gleichen). (London: Harrison. 1909. Pp. 108. *Illustrations.* 2*s.* 6*d. net.*) This is a delightful unofficial narrative of the journey of the British Mission to Fez last year; humorous, entertaining, and instructive as well, for the writer spent much time on a survey of Fez. He therefore came to know it well; he also carefully describes the country passed through *en route*, and provides good photographs. The narrative also presents intimate sidelights on current events in, and the condition of Morocco.

AMERICA.

The Chile-Argentine Frontier.

'La Frontéra Argentino-Chilena. Demarcación General 1894–1906.' Buenos Aires: Talleres Gráficos de la Penitenciaria Nacional. 1908. 2 vols. Pp. 497 + 519.

The dispute as to the boundary, which lasted sixty years, was at last brought to an end in 1903, the frontier where the commissioners of the two countries had failed to come to an agreement being defined by King Edward after investigations by a British Commission under the late Colonel Sir T. Holdich. The regions where the frontier question was submitted to arbitration were the Puna de Atacama in the north, lying between the Cordillera de los Andes and the Cordillera Real de Bolivia, and in Magallanes, where the Cordillera de los Andes is broken through by rivers flowing from a watershed to the east. The new frontier was described at the time in the *Geographical Journal*, and illustrated by a map, the line of frontier awarded by arbitration being of the nature of a compromise. As a result of this arbitration and previous concessions, Chile gained, according to the figures given in this volume, 53,213 square miles of territory. In this publication the history of the dispute is sketched, and all the treaties and acts concerning it are reproduced, and geographical co-ordinates are given of the landmarks set up on the frontier, with their altitudes, and also of other points determined by calculation during the course of the work, together with maps, diagrams of triangulation, etc. The volumes also contain some general descriptions of the country through which the frontier runs, in four chapters, the first dealing with the Puna de Atacama, of which 3900 square miles belongs to Chile, and where the northern extremity of the frontier is situated at the Cerro Zapaleri, in 22° 48′ 53″ N. lat. and 67° 11′ 18″ W. long. In the second section, from lat. 27° 46′ to Monte Tronador in lat. 41° 10′, the Andes form a continuous chain, with only one break occupied by the Lago Pirehueico. The basin of the Lago Lacar, lying to the east, was assigned by arbitration to Argentina. In the south, Patagonia and the inlet of Ultima Esperanza, the work of the commission under Colonel Holdich was particularly heavy, and the whole country was investigated. Lastly, a short sketch is given

of Tierra del Fuego, of which 12,300 square miles were secured to Chile by the treaty of 1881.

Botanical specimens were collected by some of the Argentine officials accompanying Colonel Holdich, and are catalogued here.

Southern Chile.

'Censo Jeneral de Poblacion i Edificacion, Industria, Ganaderia i Mineria del Territorio de Magallanes, República de Chile.' Por Lautaro Navarro Avaria, Médico de Ciudad, Director de la Oficina del Censo. Punta Arenas, 1908. Vol. 1, pp. 382; Vol. 2, pp. 563. *Price* $24.

The population to which this elaborate and carefully compiled census refers is only 13,309, spread over an area about one-fifth larger than England, the density being less than 0·2 per square mile. During the eleven years since the last census of the Republic in 1895 the population has increased 157·42 per cent. It seems at first singular that in such a new country the urban population in Punta Arenas, the great commercial centre, and the insignificant Porvenir in Tierra del Fuego, should form 79·81 per cent. of the total. This is due to the fact that cattle and sheep grazing, for which comparatively few men are required, is almost the only rural industry. The proportion of foreigners is large, namely 35·93 per cent., Austro-Hungarians being the most numerous with 30·71 of the foreign population, and British subjects coming second with 15·22 per cent. The tables of demography and nosology are for some reason relegated to the end of the second volume. It appears that the birth-rate is exceptionally high, 40·21 per thousand, while the mortality, though lower than in the Republic as a whole, is still 23·29, still-born infants included. It should be stated that the nomad Indians, not very numerous, are not included in the census, but only the few Indians collected at the mission stations in Tierra del Fuego.

Though grazing is the chief occupation in Magallanes, the number of domestic animals is only slightly in excess of the average for the Republic, namely 23·41 per cent. Of sheep alone the percentage is, however, 43·78. In the census year, 1906, there were in the territory 1,873,709 sheep, 37,804 cattle, and 24,010 horses, besides a few pigs and goats. The quantity of wool exported was about 147,300 cwts., valued at about £480,900, three-quarters being shipped to Great Britain. The price of the better qualities had risen to $9\frac{1}{2}d.$ per lb. in 1906. Mining is still in its infancy. In 1907 concessions were granted for 287,614 acres, mostly for auriferous sands, the other minerals being copper and coal. The foreign exports of the port of Punta Arenas in 1906 valued £639,400, and the imports £600,600. More than 32 per cent. of the imports, in value, come from Great Britain, which takes 76 per cent. of the exports.

Landed property, industries, financial undertakings, education, the press, and many other subjects are dealt with in these volumes, which are provided with diagrams, illustrations, and maps.

'The Yukon Territory.' (Ottawa: Government Printing Bureau. 1909. Pp. 140. *Map and Illustrations.*) This is a publication of the Ministry of the Interior of the Dominion Government. Within its small compass it is thorough, deals with the history of the territory, and the resources (mining, game, etc.), of the various districts in detail, and quotes a number of authorities. There is little of the dryness of the official publication here; the narrative and description are even fascinating, but full information is also given as to administrative arrangements and economic conditions.

'British Columbia Coast Names.' By Captain J. T. Walbran. (Ottawa: Government Printing Bureau. 1909. Pp. 546. *Map and Illustrations.*) This remarkable work is arranged in gazetteer form. It covers all names given from 1592 till 1906, and seeing that the derivation of the names on this sea-board have to be sought in sources so widely different as English, Spanish, and various native Indian speeches, the erudition necessary to its compilation is obvious. The book ought to set an example. It was only at the British Association Meeting at Winnipeg last year that the urgency of ethnographical investigation in its widest sense (which would embrace such research as this work contains) was insisted upon, before the data should become overlaid in the course of the development of the country.

'Canada: the Empire of the North.' By Agnes Laut. (Boston: Ginn. 1909. Pp. xxvi., 446. *Maps and Illustrations.* 7*s.* 6*d.*) A straightforward story of the Dominion, written with a full appreciation of the romance and excitement characteristic of its history. The authoress has made full use of her knowledge of the country.

'Mexico: the Wonderland of the South.' By W. E. Carson. (New York: Macmillan. 1909. Pp. xi., 439. *Map and Illustrations.* 10*s. net.*) Mexico not unnaturally attracts writers of this type of work, the catalogue of which must be long by this time. The present author, however, would seem to have studied the Mexican, his social conditions and system of government and administration more deeply than most.

GENERAL.

A Bibliography of Ptolemy's Geography.

'Ptolemy's Geography: A brief Account of all the Printed Editions down to 1730.' By Henry N. Stevens. Second Edition. London: Henry Stevens, Son & Styles, 1908.

The many editions of Ptolemy's 'Geography,' brought out at close intervals for a number of years, from 1475 onwards, possess an importance beyond that which appeals to the book collector, by reason of the constant addition of modern material at the hands of successive editors and map-makers; so that a complete collection of the various editions presents a striking view of the development of modern geographical conceptions, on the academic side, during the century or more following the discovery of America. Probably the nearest approach to a complete collection is that begun by the late Mr. Henry Stevens of Vermont, and continued by his son (the author of the present booklet), which is now in the possession of Mr. E. E. Ayer of Chicago. Excluding a limited number of early works illustrative of, or supplementary to, the 'Geography,' it embraces over forty separate editions, only one or two of any importance being wanting.* On a series of book-plates, specially designed for the collection, brief statements of the main points in regard to each edition were inserted in the respective volumes, and these statements are reprinted in the book now before us. Mr. Stevens, whose knowledge of the bibliographical history of the 'Geography' is not easily to be matched, gives also a useful outline of the main facts connected therewith, and enters into somewhat fuller detail regarding some special points which have lately come to his personal knowledge. They relate to some striking variations in the famous Ulm edition of 1482, the two issues of which are so curiously mixed up in existing copies, that out of twelve of these examined by Mr. Stevens no two have been

* Of these the Society possesses about twenty, including one specimen at least of almost every important type except that of Bologna, 1482 (?).

found exactly alike. This is of interest mainly to bibliographers, but a variation of more importance geographically is the existence, in a copy purchased in 1901 for the John Carter Brown Library, of a map of the world differing from that found in all other known copies, and, in Mr. Stevens' opinion, representing the earliest attempt, in a printed map of the world, to depart from ancient traditions. It is to be hoped that Mr. Stevens may continue his studies in this direction and eventually publish the results.

THE MONTHLY RECORD.

THE SOCIETY.

The Society's Awards for 1910.—With the approval of His Majesty the King, as Patron of the Society, the Council has awarded the royal medals for 1910 to Lieut.-Colonel H. H. Godwin-Austen, F.R.S., and Dr. W. S. Bruce. Colonel Godwin-Austen receives the Founder's Medal for his geographical discoveries and surveys along the north-eastern frontier of India. He was the pioneer explorer of the Karakoram and Kashmir borderland, and his name will always be associated with the first acquisition of accurate knowledge respecting Mount Godwin-Austen, or K_2. With his surveys he combined geological researches, and in both respects his work was of the highest order. He was the first to open up the palæontological records of the Siwaliks, and, as a member of the Eden Mission, the first to reduce to order the topography of Western Bhutan. The Patron's Medal is bestowed on Dr. Bruce for his explorations in the Arctic and Antarctic regions. In the Antarctic regions he served as naturalist on board the *Balæna* in the region south of Cape Horn in 1892–3, and in 1902–4 commanded the Scottish expedition on board the *Scotia*, which carried out important scientific researches in the Weddell sea, and traced for a distance of 150 miles the previously unknown coast which figures on the maps as Coats Land. In the Arctic regions he acted as zoologist to the Jackson-Harmsworth expedition to Franz Josef Land, as well as to Major Andrew Coats's expedition to Novaya Zemlya and the Barents sea. He has been on several expeditions to Spitsbergen, and among other explorations in the archipelago has carried out a detailed survey of Prince Charles Foreland, the results of which are nearly ready for publication. Among the other awards for 1910, the Murchison Grant falls to Dr. Carl Skottsberg for his work as leader of the Swedish expedition which, in 1907–9, conducted extensive explorations and scientific researches in the Falkland islands, Magellan straits, Tierra del Fuego, Patagonia, the Chilean Andes, and Easter island. Dr. Skottsberg has contributed a series of valuable papers to the *Journal* of the Society, embodying the chief results of this expedition. He previously served as botanist to the Swedish Antarctic expedition under Dr. Otto Nordenskiöld. The Gill Memorial is awarded to Mr. Douglas Carruthers

for his journey in North-Central Arabia, a paper on which he recently read before the Society. Before his visit to Arabia he spent a considerable time in the mountains of Turkestan, where he did important scientific work, the results of which he has communicated for publication in the *Journal*. He was also one of the naturalists engaged in the British Museum expedition to Ruwenzori. The Cuthbert Peak Grant is awarded to Lieut. C. E. Fishbourne, R.E., who, as a member of the Uganda railway extension survey party completely triangulated and surveyed an area of 3500 square miles in the Lake Kioga region. This work, which was of a high order of accuracy, he has described in the *Journal*. The recipient of the Back Bequest is Mr. Hanns Vischer, who, in 1906, journeyed from Tripoli to Nigeria, across the Eastern Sahara, and afterwards read a paper before the Society on the results.

EUROPE.

Sheep and their Products in France.—An interesting article on this subject by L. Perruchot, illustrated by a distribution map, has lately appeared in the *La Géographie*, and has been also issued as a reprint. Sheep reach a total of over 200 to the square mile in the districts of Beauce and Brie, and over 130 in Soissonais, Vexin, and Picardy. The above group of regions is sharply limited on the west, but eastwards borders on a zone with 80 to 100 sheep per square mile, ending in thinly populated Lorraine. Outside the basin of Paris, Limousin and Marche, with Champagne-in-Berry and Boischaut, have an ovine population, centring in the plateau of Milleraches, of 176 to 210 per square mile. South of the central massif the ovine population is centred in the Garigues and the Causses. In Provence and the Dauphiné Alps, sheep abound most in the plain of Crau, and next to it in Camarque, the plain of Vaucluse, and the valley of Barcelonnette. In the Pyrenean regions, the plain of Roussillon and the eastern valleys are the most populous. The two regions with least density lie, one to the west, comprising all the lands of the Armorican massif and Poitou, the other to the east, comprising the eastern part of the central massif, the Saône plain, the Savoy Alps, Jura, and Lorraine. Outside the basin of Paris, in which sheep are artificially fed in stall on trefoil, lucerne, etc., the ovine distribution above indicated represents the differences of the different parts of France in respect to their suitability as habitats for sheep. Differences of climate, relief, and soil have differentiated the sheep into the sheep of the north, of the south, of the plain, of the mountain, of calcareous, and of non-calcareous soil. Again, the sheep may be divided into the two great classes of indigenous and imported. The former comprise the sheep of the Pyrenees, of the Central Plateau, of the basin of the Loire; the latter, the "merino" in the south and the English in the north. Sheep have decreased from 32,151,430 in 1840 to 17,461,397 in 1907. The wool produced in 1907 amounted to 43,000 tons.

Mountain and Valley Winds on Lake Garda.—Some interesting investigations have lately been made with a view to ascertaining the causes of certain strong daily oscillations of level on Lake Garda. It was, of course, evident that these were connected with the daily change between mountain and valley wind, yet nothing was known respecting the joint action of the forces bringing them about either in this precise locality or generally. Dr. Albert Defant, assistant at the Central Institute for Meteorology and Geodynamics in Vienna, has, after investigations of the problem, arrived at the following principal results. From the work of

J. Hann it is known that the phenomena of mountain and valley winds depends on the formation of barometric gradients, *i.e.* neighbouring contrasts of barometric pressure. The next problem was to determine them numerically. The steepest gradient operating from the mountains towards the plain of the Po, and so producing the mountain wind of the morning hours, averages 0·85 mm. The gradient operating towards the Alps and producing the afternoon valley wind amounts to 1 mm. The facts inferred from the course of the gradients agreed perfectly with the records of the automatic limnograph at Riva. An essential factor in the operations of the gradients was thus shown to be the descent down the mountain slope of the mass of air that had been warmed over the floor of the valley and so borne upwards. In opposition to the customary diagram illustrative of mountain and valley winds, it must accordingly be emphasized that in the case of the production of the barometric contrast between mountain valley and open lowland, the determining factor is not so much the gradient operating in the longitudinal direction of the valley, but rather the gradient formed in a sense perpendicular to the direction of the valley.

ASIA.

French Exploration in Cambodia and Annam.—M. Henri Maitre, who in 1906–7 and in 1908 mapped the Darlac plateau in the southern interior of French Indo-China, writes that during the past year he has been engaged in an official mission for the exploration and survey of a practically unknown region in the extreme east of Cambodia, to the west and south-west of the field of his former explorations. He has coupled up his new surveys with those of his former expeditions, and has traversed in several directions a considerable extent of little-known country on the borders of Cambodia, Annam, and Cochin China. Geographically, the principal result of his journeys has been the exploration of a plateau region rising from 800 to 1000 metres above sea-level. It is a softly undulating country, covered with low grass, and rivers flow from it to the north to join the middle Srepok (a tributary of the Sekong, which in turn flows into the Mekong), to the east to join the upper Srepok, to the south to join the Donnai, and to the west to join the Mekong direct. These streams descend from the plateau in magnificent falls varying in height from 20 to 50 metres. To the east the plateau rises into a mountain range with peaks about 1500 metres high. The country is inhabited by savage tribes known by the general name of Moï, an Annamese word meaning "barbarians" or "savages," corresponding to the Laotian word "Kha." These tribes are of Malayo-Polynesian origin, and speak a number of languages, all quite different from one another. Some of the tribes are of a warlike disposition, and received M. Maitre in a far from friendly manner. They go almost naked, wearing only a narrow and dirty cloth round the loins, though they are fond of decorating themselves with glass beads, copper wire, and other ornaments. For weapons they use spears, arrows, and cross-bows, as well as swords and knives. Most of them possess tame elephants, which they capture in wild and uninhabited parts of the country traversed by the tributaries of the Srepok river. At the time of writing, in January last, M. Maitre was engaged in exploring the mountainous country through which flows the upper Donnai river. After surveying the middle course of this stream, which was still unmapped, he proposed to go northwards again to examine the basin of the middle Srepok.

Geological Research in Baluchistan.—Mr. E. W. Vredenburg, assistant superintendent of the Geological Survey of India, has just published two papers in the 'Records' of the survey which throw much light on the economic possibilities of Baluchistan. He and Mr. Tipper, during the winter of 1905–06, traversed a vast area of country in Sarawan, Jhalawan, Mekran, Las Bela, and Seistan, of

which very little had been previously known. Anything like detailed prospecting was impossible, owing to the limited time at their disposal: all that could be done was to indicate in what particular regions prospecting operations might be usefully carried on. In the case of coal, the only trace of it occurs in a comparatively restricted area of the Sarawan district. As regards petroleum, there are two localities where the prospect seems somewhat favourable, viz. Las Bela and southern Mekran, where the rocks belong to the Kojak, or Mekran system, and Kachhi, where they belong to the Siwaliks. The exact localities where the best chances of success are to be found are pointed out by Mr. Vredenburg, who also comments on the sulphur, salt, alumite, and gypsum occurring in the same region. In the course of the tour Mr. Vredenburg was strongly convinced of the desirability of making some provision to save the enormous amount of water that yearly runs to waste in these parts. In the western region more particularly the courses of the Hingol, the Mashkal, the Dasht, and some of their tributaries could be turned to far better account for irrigation by constructing dams at suitable places. The Dasht, especially, traverses large alluvial plains of excellent soil, while, speaking generally, Mr. Vredenburg remarks, "The potentiality of the Mekran seems to me so incomparably superior to that of any other part of Baluchistan, that the matter (the construction of dams and irrigation works) deserves careful consideration. The climate is suited to all kinds of crops: wheat, cotton, indigo, sugar-cane, rice, etc. The population appears intelligent and industrious. If the natural water-supply of the region could be made available to the fullest efficiency, the province could support three or four times its present population, and would become a prosperous annexe of the fertile portions of Sind."

The Pelliot Expedition in Central Asia.—Since the return of M. Pelliot from Central Asia, several articles on his travels and researches have appeared. M. Pelliot and his colleagues, Dr. Vaillant and M. Nouette, were received by the Société de Géographie on December 10, and the account of the proceedings will be found in *La Géographie* for January. It is there recalled that, after spending a twelvemonth at home in making preparations, the expedition left Paris on June 15, 1906, and arrived at Kashgar in August, their chief object being to conduct researches into the traces and remains of pre-Mohammedan Buddhism in Kashgaria. The route, as traced on the sketch-map, lay through Maralbashi, Aksu, Bai, the Tekes valley, Kuchar, Kurla, Karashahr, and, after a somewhat devious excursion to Urumchi and Turfan, Hami, Sha-chow (Tun-Kwang), An-su, Su-chou, Kan-chow, Lian-chow, Lan-chow, Si-ngan-fu, Chen-Chow, and by rail to Pekin. The fruit of the expedition includes several thousand rubbings of inscriptions taken by M. Nouette, which are pronounced to be of great importance. Dr. Vaillant brought back a route-survey covering more than 2000 kilometres, checked by twenty-five astronomical points. The natural history collections consist of eight hundred plants, two hundred birds, numerous mammalia and insects, as well as anthropological measurements. Paintings, carved wooden antiquities, bronzes, and earthenware objects have been also brought back, all of which it is proposed to exhibit in a special gallery of the Louvre. The *Annales de la Société de Géographie Commerciale* (Section Indo-Chinoise), fasc. 4, is devoted to the same expedition, and contains three papers by M. Pelliot, viz. a narrative of the expedition; a short treatise on the nationalities, peoples, and tribes of Chinese Turkistan; and a more elaborate description of what he calls the "mediæval library of Kansu," this being the extraordinary collection of manuscripts at Tun-Kwang, which Dr. Stein had visited only a short time before, and of which he gave such a graphic account in the *Journal* for September last. M. Pelliot appears to have devoted three weeks towards examining a good proportion of this store of thousands upon thousands of manuscripts piled up in the thousand

grottos or halls of Buddha. M. Pelliot is of opinion that the cell was walled up in the first half of the eleventh century, say in 1035. His learned comments on the manuscripts themselves and the languages in which they are written are unsuitable for record here, but it may be mentioned that the manuscripts he has brought home are written in Chinese, Mongol, Tibetan, Uigur, and Brahmi.

Nain Singh's Work in Tibet.—Referring to Dr. Sven Hedin's criticism of the Pundit Nain Singh, and especially of the vagueness of his information respecting the Lake Tashi-bup-tso (*Journal*, vol. **33**, p. 431), the well-known native explorer A-K (Nain Singh's cousin) has written to the *Pioneer* of Allahabad (February 26, 1910), pointing out that an estimate both of the length and breadth of the lake *was* made by the pundit. In Sir Henry Trotter's account of the Pundit's journey, published in the *Journal R.G.S.*, vol. **47**, 1877, it is stated that "the lake is about 13 miles in length by 8 miles in breadth." The Pundit's itinerary had previously been printed by Sir H. Trotter in his 'Report on the Trans-Himalayan Explorations. . . . during 1873–74–75,' at p. 77 of which the same statement occurs.

American Expedition in North-West China.—The March number of *La Géographie* gives particulars of the explorations of Captain Robert Clark, an American officer and member of the Paris Geographical Society, in Shan-si, Shen-si, and Kan-su, his work having been unfortunately brought to an abrupt close by the assassination of one of his companions. After having measured a base, fixed by telegraphic determination the longitude of Tai-yan-fu in Shan-si, and calculated the height of the curves along the alignment of the railway, the expedition left that city on September 27, 1908, and returned thither about twelve months later. Their route lay through Lin-hsian (Shan-si), Yulun, Sin-te-chou, Yen-nyan-fu, Fu-chou (Shen-si), King-yang-fu, Ku-yuan-chou, King-ning-chou, and Lan-chou (Kansu). Captain Clark's intention had been to travel southwards from thence into Se-chuan, but the murder of his topographer necessitated the abandonment of this project. The results consisted of the determination of eight towns by chronometrical aid, by occultation of the stars, and 24,000 square miles of plane-tabling survey, carried out by Captain Clark with the aid of an Indian surveyor, Hazarat Ali. The zoological and meteorological data were obtained by Mr. Sowerby and Captain Douglas respectively, and the photographs by Mr. Grant.

M. Bacot on the China-Tibetan Frontier.—M. Joseph Bacot, whose travels on the confines of Tibet and Western China were noticed in the *Journal* for August, 1908 (pp. 181–183), has written to Mr. Henri Cordier from Tseku, under date December 9 last, stating that he had just returned from an exploring trip in the direction of Poyul and Nepemaken, in the course of which, however, he had seen neither "the promised land of Tibet nor the Minotaur (Dalai Lama) inhabiting it." The Tibetans had stopped M. Bacot five days after crossing the Salwen, on the road to Sanga-kiu-jong, which is also the high-road to Lhasa. They were, however, accommodating, and offered M. Bacot a horse, with which he might have proceeded further for one or two days to Sanga-kiu-jong itself; but he adds that the local authorities there would certainly have arrested him without much formality. Had times been different he might have fared better, but the Tibetans were then engaged in recruiting and raising levies to repel the Chinese advance on Lhasa by way of Chamdo, and as M. Bacot had a small Chinese escort, he was looked upon with suspicion. On his return to Tseku he passed through Lu-tze-kiang, where Père Genestier, a French missionary, resides. It was about five days to the south of this that the two German explorers, Dr. Brunhuber and Herr Schmitz, were recently assassinated by Lissu tribes (see *Journal*, vol. **34**, p. 608). According to M. Bacot, the Lissus who were captured and eventually executed by the Chinese were mere puppets who had nothing to do with the murders.

AFRICA.

Origin of the Nile Valley and Gulf of Suez.—It has of late years been regarded by geologists as an almost accepted fact that a portion at least of the Nile valley, with the gulf of Suez and even the Red sea itself, are rift-valleys of the type so fully developed further south in East Africa. This view is keenly contested in the February number of the *Geological Magazine* by Dr. John Ball, of the Egyptian Geological Survey, who puts forward arguments, based on field-work lately carried out by himself, for supposing that both the Gulf of Suez and the Nile valley are true valleys of erosion. From a careful examination of the Wadi Araba —a great valley some 20 miles wide draining north-eastwards into the Gulf of Suez —Dr. Ball has, he thinks, proved conclusively that this is an eroded anticline, and that the step-like structure observable in its limiting scarps is due to local slipping down of the hard upper strata of the cliff face. In the case of the Gulf of Suez the covering of its floor by water precludes such precise observation of its structure, but Dr. Ball shows that exactly similar, even if more restricted, observations can be made, tending to prove that it too is an eroded anticline, and that the faulting along its shores is purely land-slipping. An immense amount of erosion is involved by this view, but in the case of the Araba there can be no doubt that erosion on this immense scale has actually taken place. If the above is granted, an important support is removed from the rift theory in regard to the Nile valley, which has laid particular stress on the supposed analogy with the Gulf of Suez. One of the chief exponents of this theory has been Mr. H. J. L. Beadnell, whose argument depended mainly on the proved existence of bounding faults throughout a long stretch of the valley. Dr. Ball points out that no observation has ever been made of faulted-down rocks far from the scarps, and that here too the true explanation is that the faults are landslips. In this view Mr. Beadnell himself now concurs.

The Aboinia River, Southern Nigeria.*—The map given at the end of this number is reduced from a survey executed by Lieut. J. Burn, R.N.R., who writes: "The Aboinia river, sometimes called the Itenna creek, is a small river rising somewhere in the hills in the north-west of Southern Nigeria, though as yet it has not been followed to its source. It is a tributary of the Cross river, into which it empties itself 7 miles below Obutra hill, 120 miles from Culubur. During the month of December and thenceforward until the beginning of June, there is very little water in it, only enough to float small native canoes; but when it is cleared of snags, of which it is full, it will be a very useful waterway, enabling trade to be brought down from the Hinterland, and stores, etc., to be taken up to the new Government station at Abakaliki, especially during the wet season, as then the roads are impassable. The Aboinia has gradually sloping mud banks, with dense forests on both sides, with here and there a clearing, which is thickly covered with elephant grass. There are very few villages on the banks, except in one or two places where the ground is much higher, as the river rises 20 to 25 feet during the rains, overflowing its banks and inundating the country for miles round. The natives inhabiting this district are of the Ikwe and Ezza tribes—all pagans."

AMERICA.

Explorations in the Home of the Wood Bison.—Mr. Harry V. Radford, an American naturalist, sends us some interesting notes on his recent investigations regarding the rare wood bison of North-West Canada, the home of which is in the almost unknown area west of the Slave river and north of the lower Peace, which

* Map, p. 620.

forms probably the largest still unexplored tract in the whole of North America. Mr. Radford has made some extensive journeys in this region during the past year, studying the habits, habitat, and history of the wood bison, and making track surveys so far as possible. The routes followed in these journeys, made with pack-horses in summer and with dog-sledges in winter, had, down to January last, extended to a total of 1200 miles. No previous study of the wood bison in its native haunts had ever been made, the knowledge of the animal having depended solely on a mutilated skin, without skeleton, obtained by Indians some twenty years ago, and now in the Ottawa Museum. Mr. Radford has seen eighteen wild wood bison, and studied them at close range, so that he has acquired valuable information bearing on the question of the specific difference from, or similarity with, the bison of the southern plains. He had obtained from the Canadian authorities a permit (never before granted) to procure a specimen for scientific purposes, and was successful in shooting a magnificent bull, which was hunted down on snow-shoes after a long and exhausting chase. With the help of his Indians, the traveller was able, despite the temperature of −42° Fahr., to save the complete skin and skeleton, securing a full series of body measurements, photographs, colour record, etc. By weighing the animal piecemeal, with an accurate 200-lb. steelyard, Mr. Radford determined the total weight to be 2402 lbs.—exceeding by 302 lbs. the *estimated* weight of the largest bison previously known, that killed by Hornaday in Montana in 1886. Mr. Radford states that his observations show the vague indications of existing maps relative to this region to be largely incorrect, and further details of his work will therefore be awaited with interest.

The Boundary between Peru and Bolivia, as finally fixed by the treaty of September last (*Journal*, vol. **34**, p. 573), is shown on Major Fawcett's map at the end of this number. The section in dispute was that running from the Rio Suches, in about 14° 50′ S., to the Acre on the Brazilian frontier. According to the Argentine award of last summer, the line took a course between the Madre de Dios and the Acre considerably more to the advantage of Peru than that now decided on, as it followed the Madre de Dios some 40 miles (apart from windings) below the mouth of the Heath, before striking north-west and north to the Acre. Further south, on the other hand, the change has been slightly in favour of Peru, as the line now runs a little to the east of the upper Tambopata (originally laid down as the frontier) to its right bank tributary the Lanzas.* The text, both of the Argentine award and of the final treaty, is printed in a collection of documents issued last year at La Paz by the Bolivian Ministry of Foreign Affairs.

The Madeira and Mamore Railway.—An illustrated article in the *Bulletin of the International Bureau of the American Republics* for January last reports progress in the construction of this railway, long ago projected as a means of transit past the great falls of the Madeira. The first sod was cut at San Antonio in 1871. In 1878 a survey of 320 miles was made through the forest, and a train run for 4 miles. At the beginning of this year the railway was laid a distance of 46 miles, on which five engines were already running, and six more were on the way thither. The 320 miles of line cut and surveyed in 1878 were, in January last, shortened to 200 miles, and beyond the 46 miles over which trains were running, the 154 miles remaining to complete the line were graded and almost ready for the 1-metre gauge track. The country to be served by the railway will include the area drained by the Madeira and its affluents (of which the Mamore is the chief), equal to the area of Texas (262,000 square miles), and many thousand square miles

* By an oversight, the boundary is shown on our map as following the upper Tambopata, instead of veering eastward, as it should, to the Lanzas.

of contiguous territory in Eastern Bolivia, Peru, and Brazil, which have no outlet but the channels of the Madeira and Mamore, and which by the railway are destined to a commercial importance far outlasting the tin of the first, the copper of the second, and the diamonds of the third. Besides the rubber and cacao which the areas contiguous to the great rivers actually produce, and other tropical products they might easily produce, account has to be taken of the areas of equal fertility above the river-valleys, yielding chinchona, citron, coffee, cotton, and sugar, as also continuous pasture for cattle, while fertile valleys higher still on the mountain-side have in them the latent resources of great granaries. Altogether the railway will, it is claimed, do much for the development of a region of immense extent and resources.

The Natural Regions of the Argentine Republic.—An instructive study of this subject, from the pen of the late Señor E. A. S. Delachaux, appears in vol. 15 of the *Revista del Museo de la Plata*, and forms perhaps the best general sketch of the broad physical features of the Republic that we possess. After considering the various attempts at a subdivision of its surface into natural regions made by previous writers—De Moussy, Burmeister, Napp, and others—and pointing out certain reasons for disagreeing with their conclusions, the writer puts forward his own scheme, which consists in the definition of four main physical regions, further subdivided where necessary. In regard to the main regions, there has been a broad agreement among writers on the subject, who have all recognized the importance of the great longitudinal zones running from north to south through the country. It is in defining their limits and in their further subdivision according to latitude that Señor Delachaux's scheme (which takes account of meteorological, and to some extent of anthrogeographical, factors) differs from earlier ones. He defines the three longitudinal zones of the Republic—apart from Patagonia—as (1) the littoral, (2) the Mediterranean, (3) the Montane region. The term "littoral" is applied (as by former writers) in a somewhat conventional sense, as it is applied to the whole eastern zone, east of the meridian of Cordoba. It is marked by a general uniformity of soil and surface and by but slight climatic variations, and embraces the most fertile and important portion of the Republic. Señor Delachaux divides it into an eastern, a northern, and a southern section, the first corresponding to the Mesopotamian region of De Moussy, between the Paraná and Uruguay. Topographic, meteorologic, phytogeographic, and ethnographic considerations lead to the division of the remainder along a line running approximately from Cordoba to Santa Fé, the southern portion corresponding generally with the Pampas. The Mediterranean region forms, broadly speaking, a great depression running from north to south, to the west of the littoral region, and including the Salinas Grandes and other areas of inland drainage. Its position and other conditions give it a more or less arid character, unsuited to agriculture except in favoured localities. The local and seasonal differences of temperature are much more marked than in the first region. The Montane region of the west includes the area with an altitude varying from 300 to 6000 or even 7000 metres above the sea. Apart from small areas its climate is remarkably dry, and the great variations in temperature render its character more markedly continental than even that of the Mediterranean region. It may be divided into a northern and a southern sub-region, the former forming a tableland, mostly without drainage to the sea. Lastly, Patagonia (bounded to the north by the Rio Negro), in spite of its great extension in latitude, forms a remarkably homogeneous unit—a meseta, or platform, the portion of the Cordillera included being too small to form a distinct sub-region. Its climate is mild for the latitude (though spells of exceptionally severe weather occur), the reason being the close approach of the oceans on either side. With a scanty rainfall in the east and an excessive one in the west, it is the

intermediate zone which offers the most favourable conditions for development, and it is there that colonization has made the greatest advance. The study is illustrated by maps showing various distributions as well as the proposed scheme of subdivision.

AUSTRALASIA AND PACIFIC ISLANDS.

The Lost River Wairarapa, New Zealand.—The complete alteration of the configuration and drainage system of the east coast of New Zealand in the neighbourhood of Hawke bay, consequent upon a great volcanic convulsion at the close of the Pliocene period, is discussed by Mr. H. Hill in an article entitled "The Great Wairarapa: A Lost River," published in the *Transactions of the New Zealand Institute* for 1908. Formerly the coast-line extended farther eastward than at present, and numerous streams which now form different river-systems flowed south-eastward into a great river running for a considerable part of its course parallel with the coast. But great earth-movements at the close of the Pliocene period caused a large part of the coast to disappear beneath the sea, the Wairarapa river with it, and the present outline of the coast came into shape with the formation of Hawke bay, Poverty bay, and other inlets. Before this great topographical change took place the network of tributaries from the west bared the country of much of the limestone that then covered it, replacing it by those thick, heavy deposits of pumice and shingle which are now so characteristic of the country between the Kaimanawa mountains and Tauranga-Taupo. In Poverty bay, the Kaiti hills, and other regions there are to-day abundant facts to show what the country was like before the present plain and river-valley came to be. The new rivers, like the Tukituti, which suddenly became independent streams after the subsidence of the coast, effected very active denudation; and plains like those of Poverty bay and Wairoa have all been formed by means of the materials brought down by them in time of flood; and as the process still goes on Poverty bay may once more become dry land. The soil of these newly-formed lowlands is thus naturally rich and will repay cultivation.

POLAR REGIONS.

Dr. Charcot's Antarctic Expedition.—A letter has been received from Dr. Jean Charcot, despatched from Deception island in December last by a whaling vessel. Though written before the westward cruise on board the *Pourquoi Pas?* to 126° W. long., the letter supplements in an interesting manner the telegraphic account of the expedition's work which was published in the March number of the *Journal* (vol. **35**, p. 337). Dr. Charcot warmly congratulates this country on Sir Ernest Shackleton's achievements, of which he had only just learned, and expresses the hope that Captain Scott will be successful in his attempt to reach the south pole. As regards his own expedition, though the results had not been all he had hoped for, a good deal of serious scientific work had been accomplished, and some new geographical facts brought to light. The expedition had experienced continuously bad weather, a north-east gale having been blowing almost without cessation from February to December. The ice conditions had been so bad that sledging had been very difficult and there had been no chance of giving a fair trial to the motor sledges. During the winter there had been a few cases of scurvy, and he himself had been badly attacked by myocarditis. Referring to Adelaide island, he writes: "This latter island is most interesting and curious. Biscoe considered it 8 miles in length, and it really is 70 miles in length; nevertheless, Biscoe's description is excellent in all respects, and his error is easily explained. I have taken the liberty of giving the name of Queen Alexandra to a previously

unknown part of Queen Adelaide's island. North of this island we have found and explored a large bay. Of all these coasts, including Alexander I. Land, Adelaide island, and the coast to the south, we have brought back good photographs. In fact, I can very nearly say we have taken the whole coast from Gerlache strait to the 69th parallel. Soundings have been taken regularly during our navigation. Unhappily, we have found it absolutely impossible to winter near Alexander Land or even Adelaide island. I think it is not possible to imagine a worse region for polar work—rocks, icebergs, heavy ice, no bottom for anchoring, no shelter, perpendicular cliffs of ice perpetually breaking to pieces, and hardly a corner here and there where to land. . . . Since we left our wintering quarters, we have been taking soundings, dredgings, geological specimens, etc., in the Shetlands, and my officers have done some good mapping work. This may interest more particularly your country, to whom this region belongs, and it may be particularly important, as the whaling business is going on on a large scale. Of course, all our work will be at the disposal of the Royal Geographical Society, and it may be useful, as we have found important errors even in the most recent Admiralty charts."

Scottish Antarctic Expedition.—It has been known for some time that Dr. Bruce proposes, if the requisite funds are forthcoming, to undertake a new expedition for scientific exploration in the Antarctic region. He has now issued a statement in which his plans are definitely outlined, accompanied by a map showing the route proposed to be followed. It is hoped that the expedition may sail about May 1, 1911, proceeding first to Buenos Aires, and thence steering a zigzag course to Cape Town, between 40° to 50° S., for the purpose of broadly completing the bathymetrical survey of the South Atlantic ocean begun by the *Scotia* in 1902–04. After refitting at Cape Town the expedition will sail for the Sandwich group, making further soundings *en route*, in order to test the existence of the "rise" supposed by Dr. Bruce to join the Sandwich group with Bouvet island. It will then steer for Coats Land, or some suitable spot in its neighbourhood, and here a party will be landed and a house erected. The ship will then proceed to Melbourne for the winter, carrying on deep-sea research *en route* in as high a latitude as possible. In the following spring it will proceed to McMurdo strait with a party whose task will be to push south with supplies, and endeavour to meet Dr. Bruce, who will meanwhile have set out from the base near Coats Land with a view to crossing the Antarctic Continent by way of the South Pole. Should these plans be successful, the combined parties would return to the ship and sail for New Zealand, afterwards carrying out further oceanographical work in the extreme south of the Pacific, and relieving the Coats Land party in the next spring. The project is thus an ambitious one, and it is to be hoped that the funds urgently needed to secure a chance of success may be forthcoming.

The Proposed German Antarctic Expedition.—The proceedings at the meeting of the Berlin Geographical Society on March 5 have now been reported in the new number of the *Zeitschrift* of that Society, and it is thus possible to obtain a somewhat greater insight into the details of the project for a German Antarctic expedition under Lieut. Filchner (April number, p. 455). Besides the prospective leader, both Prof. O. Nordenskjöld and Prof. Penck addressed the meeting, dwelling especially on the importance of the problem of the relations between Eastern and Western Antarctica, to the solution of which Lieut. Filchner proposes to devote his chief energies. Prof. Penck summarized the argument (based in particular on the *régime* of the winds so far as known) which may be adduced in support of the view that the main mass of Antarctic land lies over against the eastern hemisphere, and that the great escarpment of South Victoria Land explored by Scott and Shackleton is continued rather in the direction of

Coats Land than Graham Land. According to this view, Western Antarctica, from Graham Land to King Edward VII. Land, will be rather of the nature of an island lying before the continental mass. The solution of the problem would be greatly forwarded by an attempt to trace the foot of the great escarpment across the unknown area, and though this might be done no doubt by an expedition starting from the Ross sea, the fact that south of 75° all on the side of the Weddell sea is unknown ground in the chosen longitude, gives a special importance to this region as a field for exploration. Whether the sledge party could continue its march to the opposite side of the Polar area would depend on the funds available, as in this case a second ship to take out a relief party by way of the Ross sea would be necessary. The offer, under certain conditions, of an anonymous contribution of £15,000 towards the expenses of the expedition was announced at the meeting.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

The Voyage of the "Michael Sars."—The oceanographical expedition undertaken by Sir John Murray in conjunction with Dr. Hjort and other Norwegian scientists sailed from Plymouth on April 9. As announced in the *Journal* for December last (p. 684), the expedition will proceed to the coast of Morocco, making oceanographical observations *en route*, and afterwards visiting the Azores and possibly crossing the Atlantic to Newfoundland.

Ground-water or Subterranean Rivers in the Karst.—In summing up (*La Géographie*, February, 1910) the results of various subterranean explorations lately carried out, the well-known cave explorer, Mr. E. A. Martel, points out that all these recent researches (with others of earlier date) tend to disprove the theory of Prof. Grund, put forward in his "Karsthydrographie" (*Penck's Geogr. Abhandlungen*, vol. 7, 1903), that there is a continuous sheet of "ground-water" at the base of the Karst limestones, nourished by the infiltrations which take place in the caverns and other typical features of the Karst. Among recent workers in this field, one of the most active is M. Perko, who has published the results of his explorations of 1904 and 1905 (the twelfth and thirteenth seasons devoted by him to underground work) in the *Mitteilungen* of the Vienna Geographical Society (1909, No. 6). M. Perko adheres to the orthodox view that true subterranean rivers flow beneath the Karst, and denies the existence of the underground sheet postulated by Prof. Grund. M. Martel takes in turn the five principal objections raised by the latter to the existence of underground rivers, and gives reason for believing that they are all untenable, being at variance with facts ascertained by speleological research.

GENERAL.

Oxford School of Geography.—The lecture and other arrangements at this school for Easter and Trinity Terms, 1910, have lately been issued. They include, as usual, courses of lectures by the Professor of Geography and other officials of the school, as well as a weekly practical class and other special tuition to be arranged with pupils. Some of the general university courses will also have a bearing on geography, and may be attended with advantage for the Diploma in Geography.

The Eleventh International Geological Congress.—A second circular issued in March, gives further details of the arrangements for this Congress (*Journal*, vol. **32**, p. 628; **34**, p. 220), particularly respecting the excursions which are to take place before and after the meeting. This has been definitely fixed to begin at Stockholm on August 18, the session terminating on the 25th. Among the subjects of wide interest put down for discussion those of most interest

to geographers are: (1) Changes of climate since the maximum of the last glaciation; (2) the resources and distribution of iron ore throughout the world; (3) the geology of the Polar Regions. In reference to the two first, a large amount of material has been collected under the auspices of the Executive Committee, and this will be printed before the meeting and will serve as the basis of the discussions. Seven excursions have been arranged to take place, simultaneously, before the meeting, and in view of the limited number of members who will be able to take part in these, those desirous of so doing are asked to send in their names as soon as possible. In considering such applications, preference will be given to professional geologists and specialists specially interested in the places to be visited. The longest of these first excursions will be that to Ice fjord, Spitsbergen, under the guidance of Mr. G. de Geer, and this will start on July 25, the return to Stockholm being fixed for August 17. The remainder of this group will be to various parts of Northern and Central Sweden. Only short excursions will be arranged to take place during the session, and the programme of these is not fixed definitely. Seven, to various parts of Southern Sweden, will take place after the session, as well as an extension of one of these, which will not be completed till September 13, most of the others being brought to a close considerably earlier. Arrangements have been made for the Second International Agro-Geological Conference to take place at Stockholm simultaneously with the Geological Congress. The general secretary of the latter is Prof. J. G. Andersson, the postal address being "Stockholm, 3."

The Seventeenth Congress of Americanists is to take place this year in two sections, the first at Buenos Aires from May 16 to 21, the second at Mexico city during September. The reason for this division is that both cities are this year celebrating the centenary of the Independence of their respective republics, and in honour of these events the Congress will be known as the "Centenary Congress." The general programme of proceedings will follow the lines laid down for previous meetings. In addition to the meeting of this Congress at Buenos Aires, arrangements have been made for the holding in that City, July 10 to 25, 1910, of an "International American Scientific Congress," which will be divided into eleven sections, covering the whole field of scientific research.

The Geographical Society of Neuchâtel celebrated the twenty-fifth anniversary of its foundation early in February with appropriate ceremonies, various foreign societies and institutions being represented by delegates. The public meeting took place in February 5 under the presidency of Prof. Dubied, who has been for twenty-four years president of the society. Six distinguished foreign geographers, including Sir E. Shackleton, Prof. W. M. Davis, and Captain Roald Amundsen, were named honorary members in honour of the event.

OBITUARY.

Alexander Agassiz.

THE announcement of the death of the distinguished American oceanographer, Alexander Agassiz, will be received with wide regret. He died on March 28, at sea, as he was returning to America.

Alexander Agassiz, the only son of the distinguished Prof. Louis Agassiz and his first wife, Cecile Braun or Agassiz, was born at Neûchatel, Switzerland, on December 17, 1835. In 1848, when his father was elected to the Chair of Natural History in the Lawrence Scientific School at Harvard University, Cambridge, Mass.,

he went to the United States, and graduated in 1855 at Harvard, subsequently taking the degree of Bachelor of Science in Civil Engineering in 1857, and then studying chemistry. In 1859 he became assistant in the United States Coast Survey in California, making a collection of marine fishes for the Museum of Comparative Zoology at Cambridge, then under the charge of his father, and visited the principal mines of that State. On returning to Cambridge in 1860, he married Anna Russell, and in the same year he was appointed assistant zoologist at the Museum of Comparative Zoology. In 1865 he became interested in coal mining in Pennsylvania, but afterwards turned his attention to the copper-mines of Lake Superior, developing and acting as superintendent of the Calumet and Heckla Copper Mines, said to be the richest in the world, by means of which he amassed a fortune. In 1869 he went to Europe to study the principal museums, and on returning took up his duties as Assistant Curator of the Museum of Comparative Zoology, of which, after the death of his father in 1873, he became Curator, and held that post for eleven years. In 1874 he was appointed Director of the Anderson Summer School of Natural History on Penikese island, Buzzard's bay, on the coast of Massachusetts. In 1875 he made a survey of Lake Titicaca and examined the copper-mines of Peru and Chile, bringing back a large collection of Peruvian antiquities for the museum.

He visited H.M.S. *Challenger* at Halifax, Nova Scotia, in May, 1873, while on her famous cruise, and on her return to England he spent a winter in Edinburgh assisting Sir Wyville Thomson and Sir John Murray in sorting out the various groups of organisms for distribution among the specialists, and subsequently wrote the *Challenger* Report on the Echinoidea. In 1877 he began a long series of oceanography researches, taking part in the expeditions on board the steamers *Blake* and *Albatross*, and conducting explorations among the coral reefs of the world, chartering steamers for that purpose. Thus he visited the principal reefs of the West Indies, the Hawaiian islands, the Fiji islands, the Great Barrier reef of Australia, and the Maldives.

Having the means, he never hesitated to back up his opinion of what was worth doing by a free expenditure of funds, and it seems that between the years 1877 and 1900 he expended a sum exceeding £20,000 in aid of certain of the scientific departments of Harvard University. Among these objects may be mentioned the physical laboratory, the observatory, the college library, the botanic gardens, and the museum, the cost of publishing the volumes of the Memoirs and Bulletins of the Museum, the carrying on for twenty years the Newport Laboratory at Rhode island founded by him, the purchase of land for the erection of buildings, the purchase of books and of collections, and the payment of the costs of his various expeditions and coral reef investigations.

He had planned a trip among the East Indian islands for next winter, writing as follows in a private letter dated December 3 last: "I intended to go to Singapore, and see what I could do in the way of chartering a small steamer to make a cruise among the East Indian islands, and take the trip in the winter of 1910–11, or any time I found it best after consulting with the Dutch captains. I had all the necessary letters to the officials, but, alas! I had to give it up. The doctor advises a long sea-trip and rest in some warm climate, so I go to Alexandria direct from New York, and will squat in some good hotel in Luxor for a few weeks." He accordingly proceeded to Egypt, and left Cairo on his return journey on February 23, spending a few days in Rome and Paris, and reaching London on March 17.

Dr. Agassiz' work has been widely recognized, and the following distinctions are amongst those conferred upon him: Officer of the Légion d'Honneur de France, Knight of the Prussian Order pour le Mérite, Foreign Member of the Royal Societies of London and Edinburgh, of the Academies of Science of London, Paris, Berlin,

Vienna, Munich, Rome, Stockholm, and Copenhagen, Foreign Associate of the Institut de France, President of the National Academy of Sciences, Washington, and President of the American Academy of Arts and Sciences, Boston. The most recent honour conferred on him was the award of the Victoria Research Medal last year by the Royal Geographical Society of London.

Dr. Agassiz was a prolific writer on scientific subjects, his principal works being 'North American Acalephæ,' 1865; 'Marine Animals of Massachusetts Bay,' 1871; 'Revision of the Echini,' 1872–74; 'North American Starfishes,' 1877; 'Report on the Echini of the *Blake*,' 1883; 'Three Cruises of the *Blake*,' 1888; 'Contributions to American Thalassography,' 1888; 'Coral Reefs of the Hawaiian Islands,' 1889; 'Calamocrinus diomedæ,' 1892; 'General Sketch of the *Albatross* Expedition of 1891,' 1892; 'Reconnaissance of the Bahamas and Cuba in 1893,' 1894; 'Visit to the Bermudas in 1893,' 1894; 'Islands and Coral Reefs of Fiji,' 1899; 'Coral Reefs of the Tropical Pacific,' 4 vols., 1903; 'Coral Reefs of the Maldives,' 2 vols., 1903; 'Panamic Deep Sea Echini,' 2 vols., 1904; 'General Report of the *Albatross* Expedition of 1904–5,' 1906; and 'The Genus Colobocentrotus,' 1908; besides many others written in collaboration.

Dr. Agassiz was a thorough American, both in feelings and sentiment. He was not tender in his criticisms nor even-tempered when criticizing theories with which he disagreed or a line of conduct of which he disapproved, but no man was more appreciative of or more warmly supported sound scientific work and observation. During his recent visit to London he spoke of the various memoirs on marine organisms now being prepared by specialists in many parts of the world or in process of publication, these organisms having been collected during his various cruises. He will be greatly missed by all engaged in oceanographical research, especially those occupied with the zoological aspects of the subject.

At an early date he adopted views concerning the structure and origin of coral reefs opposed to those set forth by Charles Darwin, and he visited the various coral reef regions of the world with the object of making observations on this and allied subjects. It is well known that he had been for some time engaged on a general and popular account of coral islands, and he recently stated that he had written this book three times, but found it very difficult indeed to satisfactorily deal with the mass of information that had been collected. During the coming year, he stated, it was his intention to write this book for the fourth and last time, leaving out all criticism of the work of other observers, and stating exactly what he had himself observed and his own views.

I dined with him at the Berkeley Hotel, London, on the evening of March 20, and on the following evening he dined with Prof. Harmer, Sir John Jackson, and myself at the Ritz Hotel, London. On that day week news was received of his death on board the *Adriatic* on his way home, he having sailed on the 23rd. The cause of his death is up to the present unknown, but in London he seemed to be in vigorous health.

Mrs. Agassiz died many years ago. He has left behind him three sons, one of whom generally accompanied him in recent years on his voyages and travels.

The following is probably one of the last letters written by Dr. Agassiz :—

"The Berkeley Hotel, Piccadilly, W., March 17, 1910.

"My Dear Murray,

"I am very glad to hear you are to be here, and I'll be on the look-out for you on Sunday. Why can't you dine with me, and we can talk matters over, unless you are in a rush? My diagrams of Funafuti and other atolls are much like yours.

"Thank you very much for the Scotch Lake Surveys. What a fine piece of work!

"Always yours truly,

"(Signed) A. Agassiz."

John Murray.

CORRESPONDENCE.

Desert Sand-dunes.

Barna, Galway, April 5, 1910.

The perusal of Mr. Beadnell's paper and the study of his excellent photographs lead me to remind you that, in a communication I sent you on the desert west of Halfa,* I drew attention to two forms of sand-waves (?), viz. what I now hear are called barchans, and the tarbul (plu. terabil). I crossed two lines of the former west of Selima, and sighted a third; and besides saw a rocky plain covered with isolated dunes which, though equal in size, were not crescentic. When climbing the former I was obliged to go up the horns of the crescent, as the steep side was so perpendicular that no attempt could be made up it. At their foot I often found patches of scorched grass. The lines of barchans were about 3 miles wide, and the hollows between the crescent of one and the slope of the other swept quite clear, showing rocks and stones in many cases. It would appear that there is a break in the line of barchans, unless they made a wide sweep westward of Terfaui. In the line from Sheb to Terfaui their place is taken by "terabil," the north side of which is covered with bush (selim or kitr); and in many brackish water lies quite near the surface. The line of these terabil is distinctly north-west, which points to the road to Kufra being along it. (Rohlfs indicated a road from the latter place to Selima.) I cannot remember musical sand—perhaps owing to the high wind which blew when I was there.

David Comyn.

MEETINGS OF THE ROYAL GEOGRAPHICAL SOCIETY, SESSION 1909-1910.

Twelfth Meeting, April 11, 1910.—Major Leonard Darwin, President, in the Chair.

Elections.—*F. Noel Ashley; Edward Cecil Barker; Fairfax Carlyle; Rev. Arthur Crean, M.A.; Joseph de Frenes; Terence Zetland Oung; Wm. Ronald Read (King's Dragoon Guards); Sir Benjamin Simpson, K.C.I.E.*

The paper read was—

"Across Africa from the Niger to the Nile." By Dr. Karl Kumm.

Thirteenth Meeting, April 18, 1910.—Major Leonard Darwin, President, in the Chair.

The paper read was—

"Glacier Exploration in the Eastern Karakoram." By Dr. T. G. Longstaff.

* *Journal*, vol. 31, p. 442.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are as a rule written in full :—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C.R. = Comptes Rendus.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
k.k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. (Mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. (Riv.) = Review, Revue, Rivista.
S. = Society, Société, Selskab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Alps, Eastern—Lake. *Sitzb. K.A.W. Wien*, Abt. IIa. 117 (1908): 9–26. **Exner.**
Ueber eigentümliche Temperaturschwankungen von eintägiger Periode im Wolfgangsee. Von Dr. Felix M. Exner. *Diagrams.*

Alps, Eastern—Lake. **Götzinger.**
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Geomorphology—Deserts. *G.Z.* **15** (1909): 545–558. **Penck.**
Die Morphologie der Wüsten. Von Albrecht Penck.

Geomorphology—Dunes. *Ts. K. Nederland. Aardr. Genoots.* **26** (1909): 896–910. **Dubois.**
Over het onstaan van de vlakten in het duin. Door Eug. Dubois.

Geophysics. *Deutsche G. Blätter* **32** (1909): 78–80. **Nölke.**
Ueber Simroths neue Begründung der Pendulationstheorie. Von Dr. Fr. Nölke.

Glacial Erosion. *C.R.A. Sc. Paris* **149** (1909): 1413–1415. **Martonne.**
Sur l'inégale répartition de l'érosion glaciare dans le lit des glaciers alpins. Par Em. de Martonne.
See March number, p. 338.

Glaciers. *M.G. Ges. München* **4** (1909): 97–126. **Crammer.**
Struktur und Bewegung des Gletschereises. Von Prof. Dr. Hans Crammer. *Illustrations.*

Gravity. *Z. Ges. E. Berlin* (1909): 361–378. **Hecker.**
Die Schwerebestimmung an der Erdoberfläche und ihre Bedeutung für die Ermittelung der Massenverteilung in der Erdkruste. Von Prof. Dr. O. Hecker. *Maps, Illustrations, and Diagrams.*
Noticed in vol. **34**, p. 432.

Ground Temperature. *T. Edinburgh Geol. S.* **9** (1909): 167–178. **Anderson.**
On the Temperature Gradients of Deep Bores, with special reference to those of the Balfour Bore, Cameron Bridge, Fifeshire. By E. M. Anderson. *Diagram and Sections.*

Hydrology—Temperature. *Scottish G. Mag.* **25** (1909): 591–597. **Wedderburn.**
Temperature oscillations in lakes and in the ocean. By E. M. Wedderburn. *Sketch-map.*

Magnetism. *Terrestrial Magnetism* **14** (1909): 131–136. **Craig and Bauer.**
The Non-Magnetic Gas Engine of the *Carnegie*. By James Craig. The Launching of the *Carnegie* and the Departure of the *Carnegie* on her First Cruise. By Mrs. L. A. Bauer. *Plans and Illustrations.*

Meteorology. **Hildebrandsson.**
K. Svenska Vetenskaps-A. Handlingar **45** (1909): No. 2, pp. 12.
Quelques recherches sur les centres d'action de l'atmosphère. Par H. H. Hildebrandsson. III. Sur la compensation entre les types des saisons simultanés en différentes régions de la terre. *Diagrams.*

Meteorology. *Quart. J.R. Met. S.* **35** (1909): 233–248. **Rawson.**
The anticyclonic belt of the Northern hemisphere. By Colonel H. E. Rawson.
The writer had previously dealt with the corresponding belt of the Southern hemisphere (see also *Journal*, vol. **32**, p. 178).

Meteorology—Clouds. *Sitzb. K.A.W. Wien*, Abt. IIa. **117** (1908): 217–229. **Obermayer.**
Die Häufigkeitszahlen der Bewölkung. Von Albert v. Obermayer.

Meteorology—Instruments. ———
A barometer Manual for the use of seamen; with an appendix on the Thermometer, Hygrometer, and Hydrometer. Issued by the Authority of the Meteorological Committee. 6th edit. London: Wyman & Sons, 1909. Size 9½ × 6, pp. 68. *Charts, Illustrations, and Diagrams. Price* 3*d.*

Meteorology—North Atlantic. *Ann. Hydrographie* **37** (1909): 481–489. **Grossmann.**
Das Ergebnis der Versuche mit dem Bezuge von Wetter-Funkentelegrammen vom Nordatlantischen Ozean. Von [L.] Grossmann.

Meteorology—Temperature and Humidity. *Met. Z.* **44** (1909): 390-396. **Schubert.**
Ueber die Feuchtigkeit und Temperatur der Luft im Gebirge und in der freien Atmosphäre. Von Johannes Schubert. *Diagrams.*

Meteorology—Pressure. **Omori.**
B. Imp. Earthquake Investigation Com. **2** (1908): 215-222.
Note on the Long-period Variations of the Atmospheric Pressure. By F. Omori. *Charts and Diagrams.*

Meteorology—Upper Air. *P. American Phil. S.* **48** (1909): 8-33. **Blair.**
The Exploration of the Upper Air by means of Kites and Balloons. By William R. Blair. *Chart, Diagrams, and Illustrations.*

Meteorology—Upper Air. *B. Mount Weather Observatory* **2** (1909): 1-18. **Humphreys.**
Vertical temperature gradients of the Atmosphere, especially in the region of the Upper Inversion. By W. J. Humphreys. *Diagrams.*

Oceanography—Indian Ocean. **Czapek.**
Sitzb. A. W. Wien, Abt. I. **118** (1909): 231-240.
Zur Kenntnis des Phytoplanktons in Indischen Ozean. Von F. Czapek. *Illustrations.*

GENERAL.

Geography. *Scottish G. Mag.* **25** (1909): 617-635. **Lyons.**
The Scope of Modern Geography. By Captain H. G. Lyons. *Also separate copy* (9½ × 6, pp. 617-635), *presented by the Author.*

Glasgow University. **Coutts.**
A history of the University of Glasgow, from its foundation in 1451 to 1909. By James Coutts. Glasgow: J. MacLehose & Sons, 1909. Size 10 × 7, pp. xii. and 616. *Portraits and Illustrations. Price 21s. net. Presented by the University of Glasgow.*

Library Catalogue. **Wright.**
Subject-Index of the London Library, St. James's Square, London. By Dr. C. L. Hagberg Wright. London: Williams & Norgate, 1909. Size 11 × 8, pp. xxviii. and 1254. *Presented by the London Library.*

This great undertaking, involving difficulties of no ordinary kind, seems to have been carried through with a large measure of success. It will be most valuable for reference.

Mountain Ascents. *National G. Mag.* **20** (1909): 493-530. **Fay.**
The World's Highest Altitudes and First Ascents. By Charles E. Fay. *Illustrations.*

North Pacific—Coasts. **Niedeck.**
Cruises on the Bering Sea; being records of further sport and travel. By Paul Niedeck. London: Rowland Ward, 1909. Size 9½ × 6½, pp. xvi. and 252. *Maps and Illustrations. Price 21s.*

Photography—Diary.
The Wellcome Photographic Exposure Record and Diary, 1910. London: Burroughs Wellcome & Co. Size 5½ × 3, pp. 280. *Illustrations. Presented by the Publishers.*

NEW MAPS.

By **E. A. REEVES**, *Map Curator*, R.G.S.

EUROPE.

Austria. **Freytag.**
Karte des politischen Bezirkes Hietzing-Umgebung. Scale 1 : 100,000 or 1 inch to 1·6 stat. mile. Vienna: G. Freytag & Berndt, [1910]. *Presented by the Publisher.*

Austria. **Freytag.**

G. Freytag's Generalkarte von Dalmatien, Bosnien und der Hercegovina. Scale 1 : 600,000 or 1 inch to 9·5 stat. miles. Vienna : G. Freytag & Berndt, [1910]. *Price 4 kr. Presented by the Publishers.*

Austria-Hungary. **Freytag.**

Dislokationskarte des k. u. k. österr.-ungar. Heeres, der Landwehren und der Gendarmeriekorps im Jahre 1910. Scale 1 : 1,800,000 or 1 inch to 28·4 stat. miles. Vienna : G. Freytag & Berndt, 1910. *Price 4 kr. Presented by the Publishers.*

Austria—Vienna. **Freytag.**

G. Freytag's Verkehrsplan der k. k. Reichshaupt- und Residenzstadt Wien. Mit Plan und Strassenverzeichnis des XXI. Bezirkes Floridsdorf. Scale 1 : 15,000 or 4·2 inches to 1 stat. mile. Vienna : G. Freytag & Berndt, 1910. *Price 1.50 kr. Presented by the Publishers.*

British Isles—England and Wales. **Ordnance Survey.**

Sheets published by the Director-General of the Ordnance Survey, Southampton, from March 1 to 31, 1910.

County Diagrams, showing Unions, Sanitary Districts, Boroughs, and Civil Parishes. *Price 3s. each.* (1 : 2500 scale sheet-lines are now omitted, and the boundaries have been recently revised.)

1-inch—(third edition) :—

In outline, 160, 197. *Price 1s. each (engraved).*
With hills in brown or black, 160, 197. *Price 1s. each (engraved).*
Large Sheet Series, printed in colours, folded in cover or flat in sheets, 59, 72, 82, 93, 132, 142. *Price, on paper, 1s. 6d. ; mounted on linen, 2s. ; mounted in sections, 2s. 6d. each.*

6-inch—County Maps :—

With contours in black.

Hampshire, 7 sheets. **Kent**, 18 sheets. **Lancashire**, 1 sheet. **Lincolnshire**, 1 sheet. **Yorkshire**, 40 sheets. *1s. each.*

25-inch—County Maps :—

Cheshire, 18 sheets. **Hampshire**, 39 sheets. **Lancashire**, 12 sheets, **Sussex**. 25 sheets. **Yorkshire**, 57 sheets. *3s each.* And Geological Addenda.
(*E. Stanford, London Agent.*)

British Isles—England and Wales. **Geological Survey.**

4 miles to 1 inch :—

New Series, colour printed. Fishguard, Haverfordwest, Milford ; sheet (13 and part of 17). Birmingham, Northampton, Gloucester, Oxford, Worcester (Solid edition) ; sheet 15. *Price 2s. 6d. each.*

1-inch map :—

New Series, colour printed. Drift edition. Stockton, Darlington, Middlesbrough, Yarm. (Old Series, sheet 103 S.E.) Sheet 33. *Price 1s. 6d.*

(*E. Stanford, London Agent.*)

British Isles—Scotland. **Bartholomew.**

Bartholomew's "Quarter-Inch-to-mile" map of Scotland. Sheets : 5, Forth and Tay ; 6, Border Country ; 7, Galloway and Lower Clyde. Edinburgh : John Bartholomew & Co., 1910. *Price 2s. each sheet net. Presented by the Publishers.*

Reduced from Bartholomew's well-known excellent half-inch maps. The generalization of physical features and selection of names has been carefully carried out, and in some respects, specially as regards the colour tinting of the lower lands, the style in which the sheets are produced is an improvement on those on the larger scale. They are remarkably clear, and should be most useful to motorists and tourists generally.

Europe. **K. Preuss. Landesaufnahme.**

Uebersichtskarte von Mitteleuropa. Bearbeitet in der Kartogr. Abteilung der Kgl. Preuss. Landesaufnahme. Scale 1 : 300,000 or 1 inch to 4·7 stat. miles. Sheets : Cassel ; Cöln ; Antwerpen ; Düsseldorf ; Erfurt ; Gent ; Halle ; Magdeburg ; Neustrelitz ; Prag ; Rostock. Berlin : R. Eisenschmidt, 1905-07. *Price 1.50 m. each sheet.*

Germany. **Gravelius.**

Binnenschiffahrtsstrassen im Deutschen Reich im Hinblick auf die Frage der

Schiffahrtsabgaben. [Von Prof. Dr. H. Gravelius.] Scale 1 : 3,700,000 or 1 inch to 58·4 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1910, Tafel 21. Gotha: Justus Perthes, 1910. *Presented by the Publisher.*

ASIA.

Asia. **Military Topographical Dept., St. Petersburg.**

Map of the Southern Frontier Regions of Asiatic Russia. [In Russian.] Scale 1 : 1,168,031 or 1 inch to 18·4 stat. miles. Revised sheets: XIV. Urga; XXI. Hami; XXIII. Kaifeng. St. Petersburg: Military Topographical Department, 1908–09.

Asia. **Service Géographique de l'Armée, Paris.**

Carte de l'Asie. Scale 1 : 1,000,000 or 1 inch to 15·7 stat. miles. Sheet: Teheran. Paris: Service Géographique de l'Armée, 1908. *Price 1.25 fr. each sheet.*

Central Asia. **Schultz.**

Uebersicht über die Pamirexpedition 1909 von Arved v. Schultz. Scale 1 : 3,000,000 or 1 inch to 47·3 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1910, Tafel 22. Gotha: Justus Perthes, 1910. *Presented by the Publishers.*

Eastern Asia. **Toepfer.**

Eisenbahnbauten im russisch-japanisch-chinesischen Grenzgebiet Ostasiens. [Von Major Toepfer.] Scale 1 : 5,000,000 or 1 inch to 78·9 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1910, Tafel 30. Gotha: Justus Perthes, 1910. *Presented by the Publisher.*

Java. **Topographical Bureau, Batavia.**

Topographische Kaart der Residentie Cheribon. Scale 1 : 100,000 or 1 inch to 1·6 stat. mile. 6 sheets. Batavia: Topographical Bureau, 1909.

Gives full information by means of colours and symbols as to character of land, plantations, means of communication and many other subjects, with full explanation of symbols employed. An inset chart shows the triangulation upon which the map is based. Apart from the fact that the mountainous regions are somewhat too dark, this is a good specimen of colour-printing.

AFRICA.

Africa. **Ghisleri.**

Atlante d'Africa. 36 Tavole colorat econ 200 pagine di testo di Notizie Geografiche, Economiche e Statistiche illustrate da 160 cartine di dettaglio e piante topografiche disegnate in base agli ultimi dati degli esploratori dal Prof. Arcangelo Ghisleri. Bergamo: Istituto Italiano d'Arti Grafiche, 1909. *Price 25l. Presented by the Publishers.*

In this atlas Prof. A. Ghisleri deals with the geography of Africa in a very complete manner. There is a series of general maps of the different regions and political divisions on the scales of 1 : 4,000,000 and 1 : 8,000,000, with larger scales for special sections, and on the back of each of these is given instructive letterpress to accompany the map, together with plans of towns, ports, railways, rapids and waterfalls, rainfall, diagrams showing imports and exports, facsimiles of interesting old maps of the same region shown on the general map, and other subjects. Many of the maps are orographically coloured. A special division of the atlas deals with the geology of Ethiopia, and is accompanied by a geologically coloured map on the scale of 1 : 4,000,000. The Italian colony of Eritrea is allotted a section to itself, and is represented by an orographically tinted map on the 1 : 1,000,000 scale, in addition to many plans and diagrams in the accompanying text. The atlas closes with an interesting chapter on the historical geography of Africa, illustrated by facsimile maps and plans from the earliest times.

Egypt. **Survey Department, Cairo.**

Map of Egypt. Scale 1 : 50,000 to 1·3 inch to 1 stat. mile. Sheets: S.E. XXXV.–VIII. El Allaqi; XXXVI.–VII. Seyala; XXXVII.–IV. Aneiba; XXXVII.–VII. Sebua. Cairo: Survey Department, 1909. *Presented by the Director-General, Survey Department, Cairo.*

French Central Africa. **Delingetti.**

Service Géographique de l'Afrique Équatoriale Française. Carte Général de l'Afrique Équatoriale Française publiée par ordre de M. le Gouverneur Général

M. Merlin dressée et dessinée par G. Delingette. Scale 1 : 1,000,000, or 1 inch to 15·8 stat. miles. Sheets 1, 2, and 3. Paris: Augustin Challamel, 1910.

A glance at this map will show what great progress has been made in recent years with the exploration of this part of Africa. The region included in the three sheets extends from Lake Chad and the country to the north as far south as the Ubangi river in lat. 1° N., and, except in the northern sheet, there are few areas that are now altogether untraversed or can be considered as entirely unexplored. The map has been compiled chiefly from the route surveys and compass sketches of French officers. According to the index two other sheets will be published, and the map will then embrace the whole of French Equatorial Africa. The map is clearly drawn and printed in colours.

German South-West Africa. **Gürich.**

Die Marmorvorkommen in Deutsch Südwestafrika und die Marmor-Abbaufelder der Afrika-Kolonial-Marmor-Gesellschaft Hamburg. Auf Grund der Angaben von Prof. Dr. G. Gürich. Scale 1 : 1,000,000, or 1 inch to 15·8 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1910, Tafel 28. Gotha: Justus Perthes, 1910. *Presented by the Publisher.*

Shows the occurrence of marble in German South-West Africa.

Morocco. **Gentil and Chesneau.**

Atlas Marocain. Par Louis Gentil. Carte dressée et dessinée avec la collaboration de Marius Chesneau. Scale 1:400,000 or 1 inch to 6·3 stat. miles. Paris: Henry Barrère, 1909. *Presented by M. Louis Gentil.*

This sheet extends from Mogador and the Wadi Sus on the west coast to Demrat and Tikirt on the east, and thus includes Marrakesh and the mountainous region to the south. It has been compiled from latest route traverses and sketches, and forms one of a series of similar sheets now in course of publication. Care has been taken in the production and colour printing, and a considerable amount of information is given by symbols regarding villages, wells, means of communication, and other important matters.

Southern Nigeria. **Beverley.**

The Central and Eastern Provinces of Southern Nigeria, 1910. Compiled under the authority of His Excellency Sir Walter Egerton, K.C.M.G., Governor and Commander-in-Chief, by Captain W. H. Beverley, Intelligence Officer, Southern Nigeria. Scale 1 : 500,000, or 1 inch to 7·8 stat. miles. London: Edward Stanford, 1910. *Presented by Captain W. H. Beverley.*

This is by far the best general map of Southern Nigeria that has yet been produced, and until a regular survey has been undertaken it will doubtless be considered the standard map of the country. It covers nearly the same area, and is on the same scale as Captain Woodroffe's map, but is really much more than a new edition of this, since it is an entirely new compilation and drawing, prepared with great care and judgment by Captain W. H. Beverley, Intelligence Officer of Southern Nigeria. The material utilized in the compilation comprise (*a*) triangulation surveys by the recent Boundary Commissions on the frontier of the Cameroons, and by Royal Engineer officers in the Oban hills; (*b*) accurate traverses made in connection with the telegraph construction by Captain Woodroffe, R.E., and by Captain Moir, D.S.O., R.E. The work of the latter officer was particularly valuable, as it runs right across the country from north-west to south-east, and provides means of adjustment for the more approximate route traverses; (*c*) waterway surveys by the Southern Nigeria Marine; (*d*) district and route sketches by military and civil officers. In addition to the above, about forty astronomically determined positions have been utilized, and full advantage has been taken of all previously existing published maps of the country. As regards the more accurate survey work, this naturally presented little difficulty in the preparation of the map, and being first plotted on the projection, the remaining more approximate compass traverse and sketches were adjusted to it, which called for great care and discrimination, as in many cases the lack of agreement between them was considerable. However, Captain Beverley has made the best of these rougher sketches by taking means and checking them one with another at points of crossing and coincidences. Under the title a note gives full information as regards symbols employed, style of writing indicating relative importance of towns, villages, roads, and other kindred subjects. Altogether the map is a most creditable production, and a comparison of it with the edition of Captain Woodroffe's map published five years ago will show what a large amount of exploratory and survey work has recently been carried out in this country.

Tunis. **Service Géographique de l'Armée, Paris.**

Carte de la Tunisie. Scale 1:50,000 or 1·3 inch to 1 stat. mile. Sheet XXXI. Ghardimaou. Paris: Service Géographique de l'Armée, 1909. *Price* 1.50 *fr. each sheet.*

AMERICA.

Bolivia. **Herzog.**

Reisewege in Ost-Bolivien (Puerto Suarez bis Santa Cruz—Hügelland von Velasco—Missionen von Guarayos). Von Dr. Th. Herzog. Scale 1:2,000,000 or 1 inch to 31·5 stat. miles. *Petermanns Mitteilungen*, Jahgang 1910, Tafel 25. Gotha: Justus Perthes, 1910. *Presented by the Publisher.*

Canada. **Dept. of the Interior, Ottawa.**

Standard Topographical map of Canada. Scale 1:250,000 or 1 inch to 3·9 stat. miles. Sheet 10 s.w. Ottawa, Ontario. Ottawa: Department of the Interior, Topographical Surveys Branch, 1910. *Presented by the Department of the Interior, Ottawa.*

Canada. **Dept. of the Interior, Ottawa.**

Sectional map of Canada. Scale 1:190,080 or 1 inch to 3 stat. miles. Sheets: 14, Prince Creek, revised to October 13, 1909; 22, Dufferin, revised to November 22, 1909; 68, Swiftcurrent, revised to October 23, 1909; 120, Qu'Appelle, revised to November 3, 1909; Sullivan Lake, revised to November 27, 1909; 264, Brazeau, revised to November 15, 1909; 266, Ribstone Creek, revised to December 1, 1909; 316, Vermilion, revised to October 21, 1909. Ottawa: Department of the Interior, Topographical Surveys Branch, 1909. *Presented by the Department of the Interior, Ottawa.*

AUSTRALASIA.

Western Australia. **Dept. of Lands and Surveys, Perth.**

Plans of Locations of Land open for Selection in the Avon, Nelson, and Plantagenet Districts. 5 sheets. Various scales. Perth: Department of Lands and Surveys, 1909. *Presented by Captain J. Fitzgerald Ruthven.*

GENERAL.

World. **Bartholomew and Lyde.**

A School Economic atlas. By J. G. Bartholomew, LL.D., with Introduction by L. W. Lyde, M.A. Oxford: Clarendon Press, 1910. *Price* 2*s.* 6*d. net. Presented by the Publisher.*

A useful little school atlas, well arranged, and, considering the number and quality of the maps, remarkably cheap. It consists of sixty-four sheets of maps showing physical features, meteorology, population, occupations, races, and religions of mankind, followed by maps illustrative of the natural resources, economics, and commercial products of all parts of the Earth. In addition to the maps there are many diagrams giving graphically, and in figures, statistical information upon subjects such as trade, imports, and exports of various countries. At the commencement of the atlas are about eleven pages of introductory and explanatory letterpress, by Prof. W. L. Lyde.

World. **Johnston.**

The Handy Royal Atlas of Modern Geography, exhibiting the present condition of geographical discovery and research in the several countries, empires, and states of the world. By the late Alexander Keith Johnston, LL.D., F.R.G.S., F.R.S.E. With additions and corrections to the present date by G. H. Johnson, F.R.G.S. Edinburgh and London: W. & A. K. Johnston, Ltd., 1910. *Price, bound half morocco,* £1 17*s.* 6*d. Presented by the Publishers.*

The maps in this well-known general atlas have received a considerable amount of revision and correction, but some of them still require further attention. New maps of the South Polar Region, Central Europe, South-East Siberia, Burma, Siam, Southern Rhodesia, Natal and Orange River Colony, Mexico, Chile, and Argentina have been added.

World. **Westwell.**

The Time-indicating Cylinder. Designed by J. W. Westwell. London: The Educational Supply Association, [1910]. *Price* 2*s.* 6*d. net. Presented by J. W. Westwell, Esq.*

One of the many simple educational arrangements recently devised for showing the difference in time between places, and the relation between time and longitude. It consists of a hollow cardboard cylinder, 10 inches high by 4 inches in diameter, round the outside of which is mounted an outline map of the world on Mercator's projection, with the British Empire coloured in red. The top, or lid, of the cylinder is marked off in

twenty-four hours and quarters of an hour, so that, by setting the Greenwich meridian on the map to the Greenwich time shown on this movable top, the time at any place can, of course, be read off approximately. So far, all well and good, but why use a map on Mercator's projection, which, owing to tremendous distortions in high latitudes, is most objectionable for school purposes? The same result as regards relative time and longitude could have been obtained with a hollow globular-shaped map on a flat base, with a movable top or a graduated band, or circle made so that it could be revolved round the equator.

CHARTS.

Admiralty Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published by the Hydrographic Department, Admiralty, during February, 1910. *Presented by the Hydrographer, Admiralty.*

New Charts—No. 3737, Baltic sea: Berghamn to Venö, 3*s*. 3738, Baltic sea: Berghamn to Abö, 3*s*. 714, Africa, West Coast: Cape Kantin to Cape Sim. Plans: Safi (Asafi), Mogador (Suira), 3*s*. 2153, Malacca strait: Port Swettenham (Kwala Klang), 3*s*.

Atlantic, North. **U.S. Hydrographic Office.**

Pilot chart of the North Atlantic Ocean, March, and April, 1910. Washington: U.S. Hydrographic Office, 1910. *Presented by the U.S. Hydrographic Office.*

Atlantic, North, and Mediterranean. **Meteorological Office.**

Monthly meteorological charts of the North Atlantic and Mediterranean, April, 1910. London: Meteorological Office, 1910. *Price 6d. each. Presented by the Meteorological Office.*

Atlantic, South. **U.S. Hydrographic Office.**

Pilot chart of the South Atlantic Ocean, March, April, and May, 1910. Washington: U.S. Hydrographic Office, 1910. *Presented by the U.S. Hydrographic Office.*

Indian Ocean. **U.S. Hydrographic Office.**

Pilot chart of the Indian Ocean, March, and April, 1910. Washington: U.S. Hydrographic Office, 1910. *Presented by the U.S. Hydrographic Office.*

Indian Ocean and Red Sea. **Meteorological Office.**

Monthly meteorological charts of the Indian Ocean north of 15° S. lat. and Red Sea, April, 1910. London: Meteorological Office, 1910. *Price 6d. each. Presented by the Meteorological Office.*

Pacific, North. **U.S. Hydrographic Office.**

Pilot chart of the North Pacific Ocean, April, 1910. Washington: U.S. Hydrographic Office, 1910. *Presented by the U.S. Hydrographic Office.*

PHOTOGRAPHS.

South America. **Fisher.**

Eighty-one photographs of South America, taken by F. G. Fisher, Esq. *Presented by F. G. Fisher, Esq.*

The journey upon which these photographs were taken is described by Major Fawcett in the present number of the *Geographical Journal*. Mr. Fisher was his principal assistant upon the recent expedition for surveying the boundary between Bolivia and Brazil. He has evidently made good use of his opportunities for obtaining photographs of the little-known region traversed by the expedition, as well as the more frequented places touched at on the voyage.

(1) Leaving Buenos Aires under escort; (2–4) Tigre, near Buenos Aires; (5) Buenos Aires; (6 and 7) Racecourse, Buenos Aires; (8) Dock, Buenos Aires; (9) Washing-day; (10) Monte Video; (11) Rosario; (12) Asuncion; (13) Railway station, Asuncion; (14 and 15) Loading oranges near Asuncion; (16) The Rio Paraguay; (17) Government troops going to suppress insurrection, Paraguay; (18 and 20) Revolutionary captured boat; (19) Government troops proceeding up river; (21) Revolutionary boat near Puerto Mortinho; (22 and 23) Puerto Mortinho; (24) Passing through the revolutionary boats; (25 and 26) Fort Coimbra; (27) Brazilian Commission leaving Corumba; (28) San Luio de Caceres; (29) Crossing river near Matto Grosso; (30 and 31) Loading canoes, Matto Grosso; (32) Old cathedral, Matto Grosso; (33) Telegraph office, Motto Grosso; (34) Bullock waggon crossing Rio Barbara; (35–37) Crossing Rio Barbara; (38) Party at source of Rio Verde; (39) Women washing, Descalvados; (40 and 41) Camp at Cabeza de Toro; (42) Church, San Matiao; (43) Women washing, Matto Grosso; (44) Down the Guaporé; (45 and 46) Crossing the Rio Guaporé; (47) In the Ricardo Franco plateau; (48 and 49) The

Ricardo Franco ranges; (50) Overlooking Matto Grosso, Ricardo Franco ranges; (51 and 52) Guaqui, Lake Titicaca; (53) La Paz; (54 and 55) Inca ruins; (56) Pack mules, high plateau, Mollendo-La Paz railway; (57) Sand hills, Mollendo-La Paz railway; (58 and 59) Lake on high plateau, Mollendo-La Paz railway; (60 and 61) On the high plateau, Mollendo-La Paz railway; (62) Mollendo; (63) Near Mollendo; (64) Iquiqui; (65–69) Valparaiso; (70–72) Magellan straits; (73–77) Port Stanley, Falkland islands; (78) Stanley harbour, Falkland islands; (79) Panama; (80) Near Panama; (81) Kingston, Jamaica.

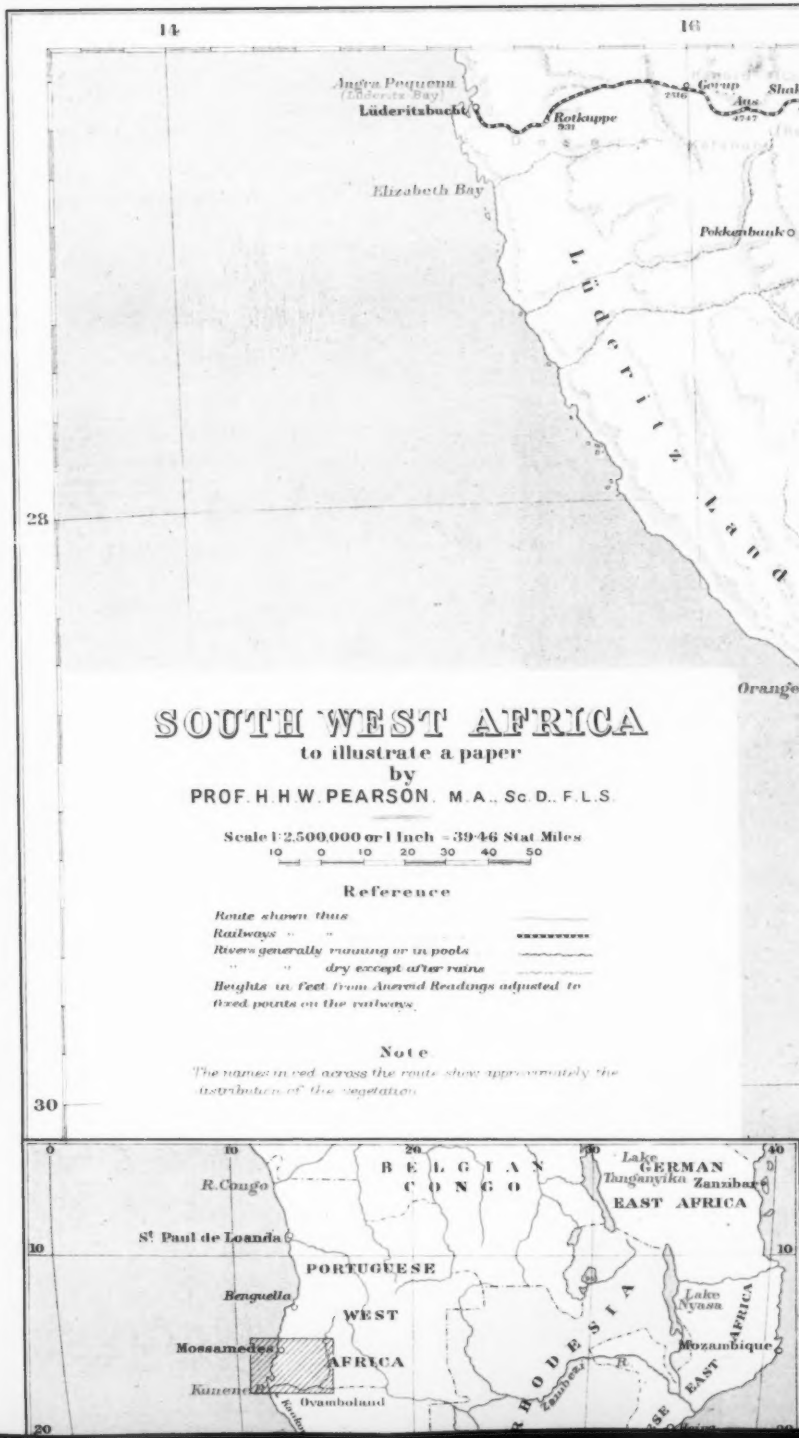
West Indies and South America. **Bingham.**

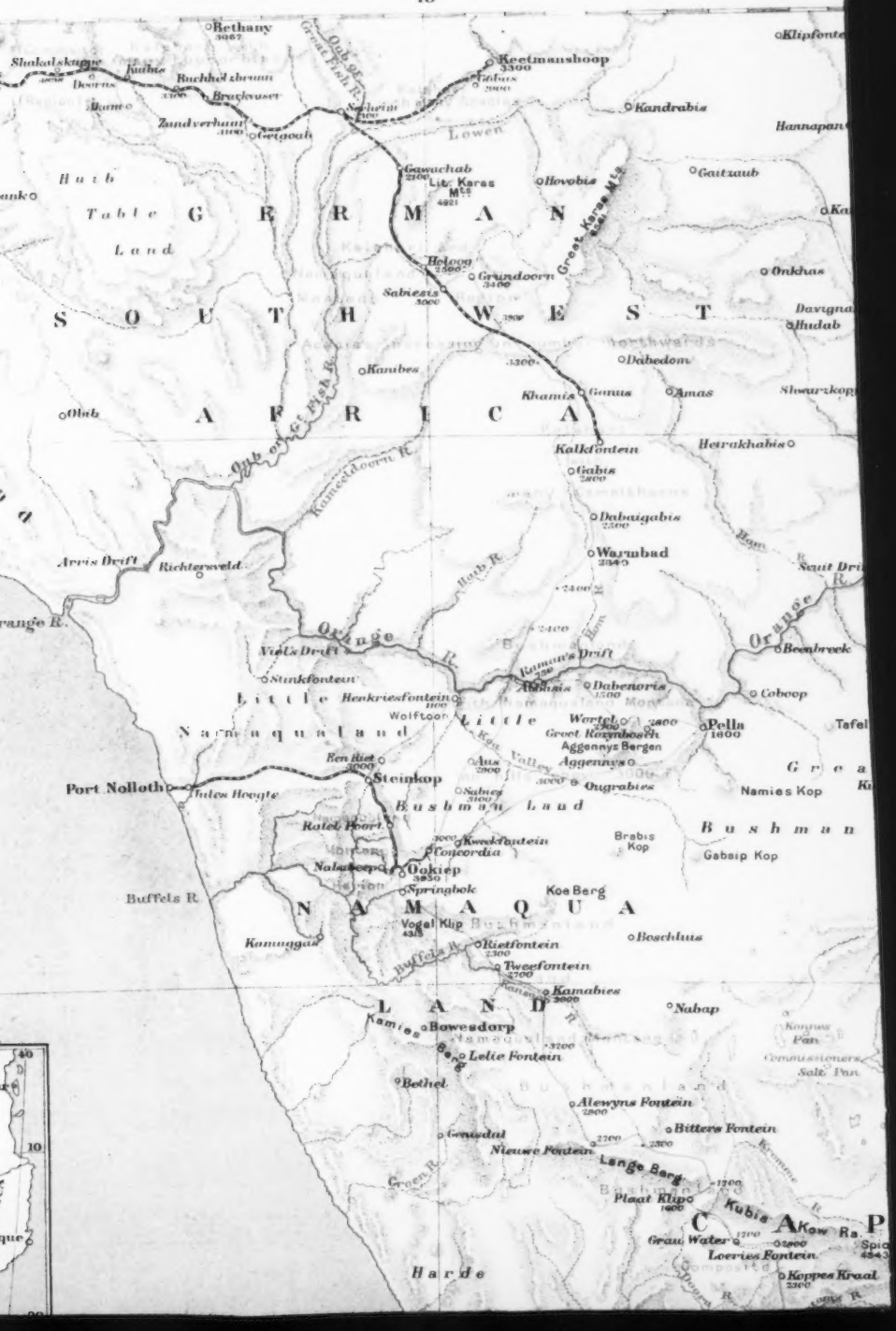
Two hundred and fifty-six photographs taken during a visit to Vieques, Porto Rico, Curaçao, Venezuela, and Colombia in 1906–1907, by Prof. Hiram Bingham, PH.D. *Presented by Prof. Hiram Bingham.*

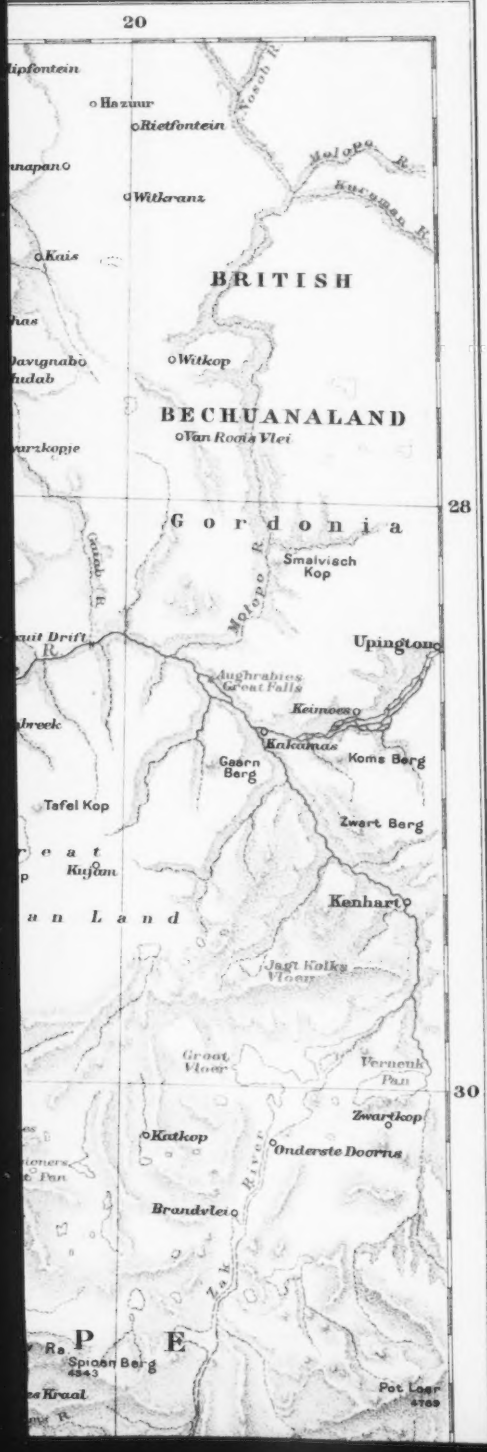
A series of photographs of considerable geographical value taken during the recent scientific travels of Prof. Bingham of Yale university. They vary in quality as photographic specimens, but the subjects are decidedly typical and well selected.

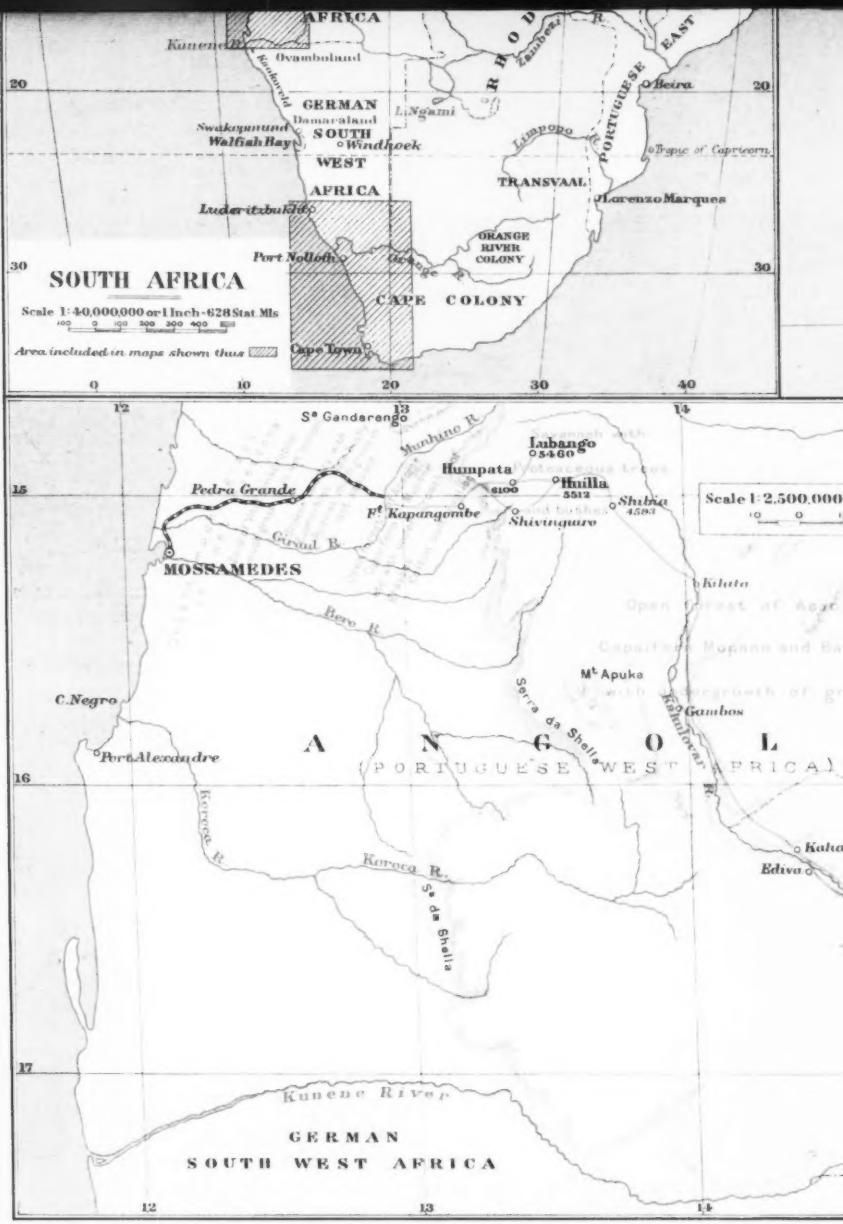
Island of Vieques: (1–9) Views in the island; (10) The Alcalde of Vieques. *Porto Rico:* (11 and 12) Views of San Juan. *Curaçao:* (13–21) Views in the island. *Venezuela:* (22–99, 103–108, 122–124 and 129) Views in and around Caracas: (100–102) Photographs of portraits in the Consejo municipal; (109–114) Tombs and statues in the National Pantheon; (115–121, 127 and 128) Portraits and paintings in the National Capitol; (125) General Ybarra; (126) Son of General Ybarra; (130–139) Views in and around Valencia; (140) On the bank of Rio Guataparo; (141–144) Views near the battlefield of Carabobo; (145–155) Views of the battlefield of Carabobo; (156) Crossing the Rio Chirgua; (157) Distant view of Tinaquillo; (158–160) The Posada at El Salto de Tinaco; (161 and 162) El Salto de Tinaco; (163) A street in Tinaco; (164–168) Views of San Carlos; (169) The Posada at Camoruco; (170) Crossing the river Cojedes; (171) Church of San Rafael; (172) The main street of Agua Blanca; (173) A typical cattle-owner at Agua Blanca; (174) A church in Acarigua; (175) The battlefield of Araure; (176) A bit of the road from Acarigua; (177) The village of Aparicion; (178–181) Views of Guanare; (182) The river Guanare; (183) Ruins of the old church at Tocupido; (184) The Posada on the left bank of the river Bocono; (185) The ferry over the river Bocono; (186) Posada at Sabaneta; (187) The river La Yucca; (188) Ruins of El Marques at Barinas; (189) The plaza of Barinas; (190) Halt by the roadside to Barinas, the river Paguei; (191) A Bongo on the river Paguei; (192) Driving cattle at corral Falso de Paez; (193) Ranchmen at corral Falso; (194) Interior of hut at Acanagua; (195) The owner of the ranch called La Calsada de Paez; (196) Looking south-south-east from La Calsada de Paez; (197–199) Views from the left bank of the river Apure; (200) Group of Venezuelans at Boca Suripa; (201) Sunrise on the Apure river at La Tigra; (202) Agarrobo landing on the Apure river; (203) Palmarito; (204) A new house near Periquera; (205) The proprietor of the posada of Los Corrales near Periquera; (206) The people of Caña Flores; (207) A typical householder of Caña Flores; (208) The posada at El Amparo; (209) A street corner in El Amparo; (210) The arrival of the cart at El Amparo, completing the journey across Venezuela; (211) The cart mules, at the end of their long walk across Venezuela; (212) A leading physician of Periquera; (213) Regulars on the frontier at El Amparo; (214) General Vallee, the governor of the frontier provinces at Periquera; (215) The alcalde of El Amparo. *Columbia:* (216) On the banks of the Caño Guaratarito; (217) Yaruro Indians near the river Ele: (218 and 219) The deserted Yaruro village near the river Ele; (220 and 228) Our caravan crossing the llanos of Casanare; (221 and 222) The flooded Caño Guato; (223) View from El Limbo; (224) The ranch house at El Limbo; (225) The plaza of San Salvador; (226) Colombians in front of the posada at San Salvador; (227) Resting by roadside; (229 and 231) The llanos of Casanare near Moreno; (230) The plaza of Pore; (232) A group at Nunchia; (233) View from the road from Paya to Pisva; (234) The author and his mule after his journey across Venezuela and Colombia; (235–256) Views in and around Bogota.

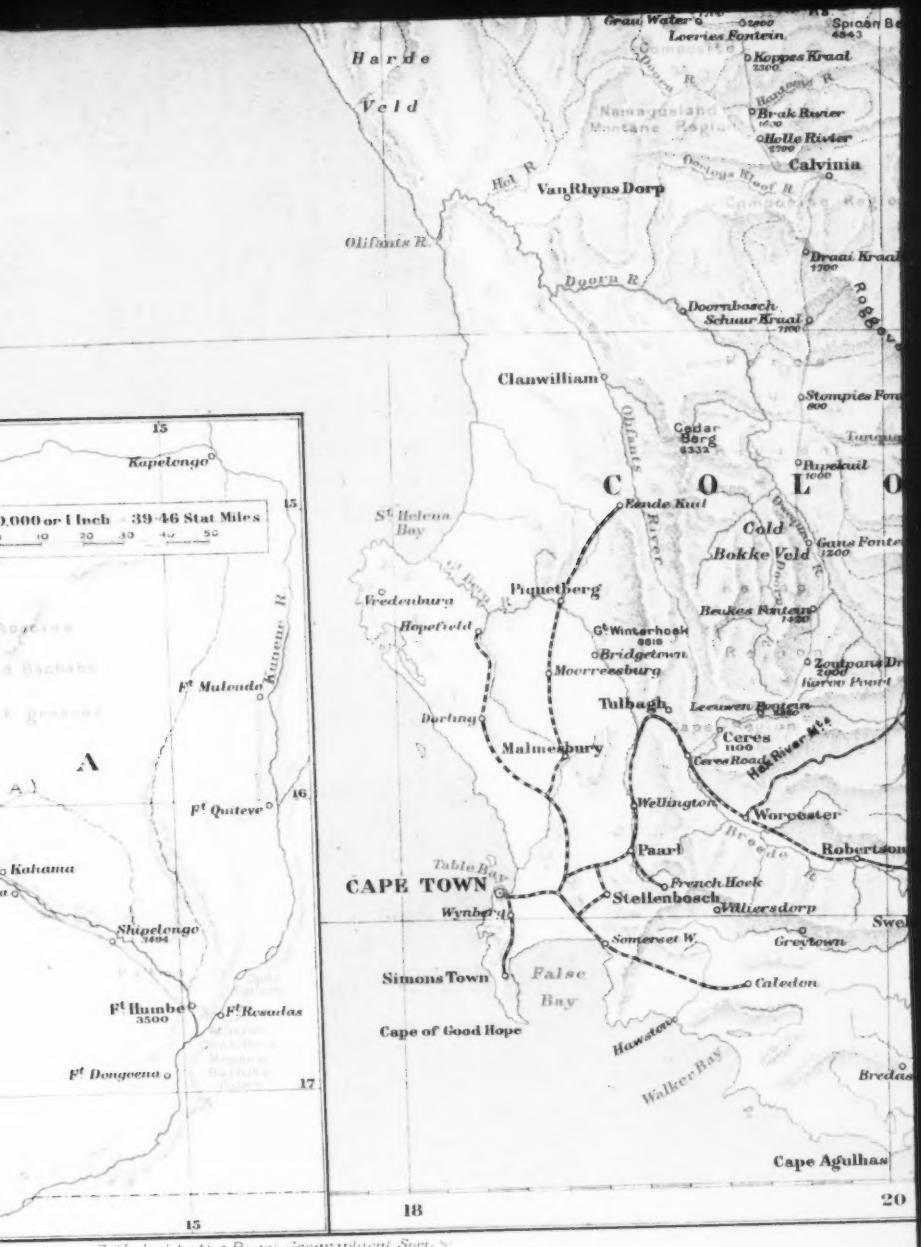
N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.


14
16
Angra Pequena
(Shearer's Bay)
Lüderitzbucht
Rotkuppe
931
Elizabeth Bay
Pokkambank
28
Orange
30
SOUTH WEST AFRICA
to illustrate a paper
by
PROF. H. H. W. PEARSON, M.A., Sc.D., F.L.S.
Scale 1:2,500,000 or 1 Inch = 39·46 Stat Miles
10 0 10 20 30 40 50
Reference
Route shown thus
Railways " "
Rivers generally running or in pools
" " dry except after rains
Heights in feet from Aneroid Readings adjusted to fixed points on the railways
Note
The names in red across the route show approximately the distribution of the vegetation
0
10
20
30
40
BELGIAN CONGO
R. Congo
St Paul de Loanda
PORTUGEESE WEST AFRICA
Benguella
Mossamedes
Kunene R.
Ovamboland
Lake Tanganyika
GERMAN EAST AFRICA
Zanzibar
Lake Nyasa
Mozambique
RHODESIA
EAST AFRICA
Zambesi R.


Bethany
3067
Shakalskaap
Judhie
Ruckhed zbraun
Brackwasser
Zandverhaun
Gertgoab
Keetmanshoop
3300
Gibeon
Schwein
Kandrabis
Hannapan
Lowen
Gawachab
2100
Lit. Karas Mts
4921
Ilovobis
Gautzaub
Great Karas Mts
Huib
Table Land
GERMAN
Belvog
2500
Grundoorn
3400
Onkhas
SOUTH WEST
AFRICA
Sabiesis
3000
Davignaa
Jhudab
Kanubes
3300
Dabedom
Olab
Khamis
Genus
Amas
Swaarzkop
Orange River R.
Kalkfontein
Herrakhabis
Kamiesdoorn R.
Gabis
2400
Dabaigabis
2500
Arvis Drift
Richtersveld
Warmbad
2340
Scuit Dri
Hoib R.
Orange R.
Viol's Drift
Beenbreck
Kamaus Drift
Stinkfontein
Little Namaqualand
Henkriesfontein
1100
Wolftoon
Dabenoris
1500
Coboop
Little Wortel
Great Kaymhoogh
Aggenys Bergen
Aggenys
Pella
1600
Tafel
Ben Riet
Steinkop
Port Nolloth
Tules Hoogte
Aus
2800
Ougrabies
Namies Kop
Great Kuboos Valley
Bushman Land
Rotel Poort
Kweekfontein
Concordia
Brabis Kop
Bushman
Gabsip Kop
Nalatsoep
Dakiep
3850
Springbok
2700
Koe Berg
2800
Buffels R.
NAMAQUA
Vogel Klip
4350
Kamuggas
Rietfontein
2300
Boschluis
Buffels R.
Tweefontein
2700
Kamabies
2800
LAND
Nabap
Kamies Berg
Bowesdorp
Lelie Fontein
3200
Bethel
Alewyns Fontein
2800
Bitters Fontein
Genisdal
2700
2300
Nieuwe Fontein
Lange Berg
Green R.
Plaat Klipp
1600
Kubis
Kow Ra
Graw Water
1700
2000
Loeries Fontein
Koppes Kraal
2300
Harde
Kamies Pan
Commissioners Salt Pan


20
Hazuur
Rietfontein
Witkranz
Kais
BRITISH
BECHUANALAND
Witkop
Van Rooi's Vlei
28
Gordonia
Molopo R.
Kuruman R.
Smalvisch Kop
Upington
Aughrabies Great Falls
Keimoes
Kakamas
Koms Berg
Georn Berg
Tafel Kop
Zwart Berg
Kenhart
Jagt Kolks Vloer
Great Vloer
Vermenk Pan
30
Zwartkop
Katkop
Onderste Doorns
Brandvlei
Spioen Berg
4343
Pot Loer
4769


AFRICA
Kunene R.
Ovamboland
Kalahari Desert
RHODESIA
Zambesi R.
EAST
20
GERMAN
Damaraland
Ngami L.
Beira
Swakopmund
Walfish Bay
SOUTH
Windhoek
Limpopo
PORTUGUESE
Tropic of Capricorn
WEST
AFRICA
TRANSVAAL
Lorenzo Marques
Luderitzbuk
ORANGE
RIVER
COLONY
Port Nolloth
Orange R.
30
SOUTH AFRICA
Scale 1:40,000,000 or 1 Inch = 628 Stat. Mls
CAPE COLONY
Area included in maps shown thus
Cape Town
0
10
20
30
40
12
13
14
Sa Gandarengo
Munhine R.
Lubango
5460
Humpata
6100
Huilla
5512
Shiba
4593
15
Pedra Grande
Pt Kapangombe
Shivinguaro
Scale 1:2,500,000
Giraul R.
MOSSAMEDES
Kilulo
Bero R.
Mt Apuka
Serra da Shella
Kahitovar R.
C. Negro
Gambos
Port Alexandre
A N G O L A
(PORTUGUESE WEST AFRICA)
16
Kunene R.
Kunene R.
Sa da Shella
Kaha
Ediva
17
Kunene River
GERMAN
SOUTH WEST AFRICA
12
13
14



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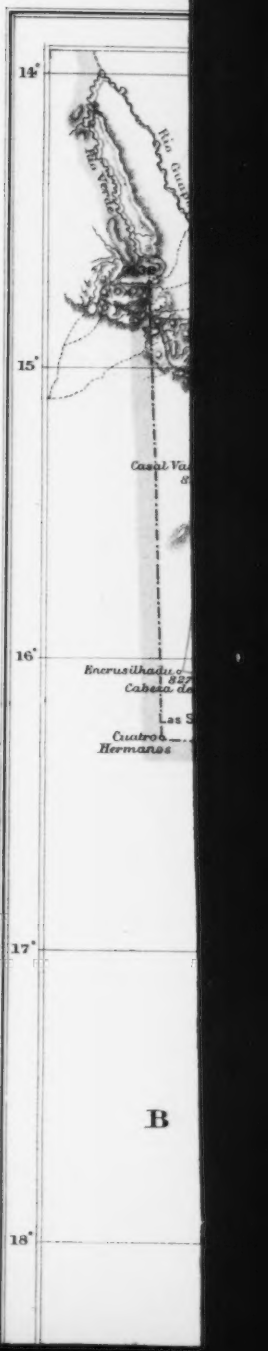
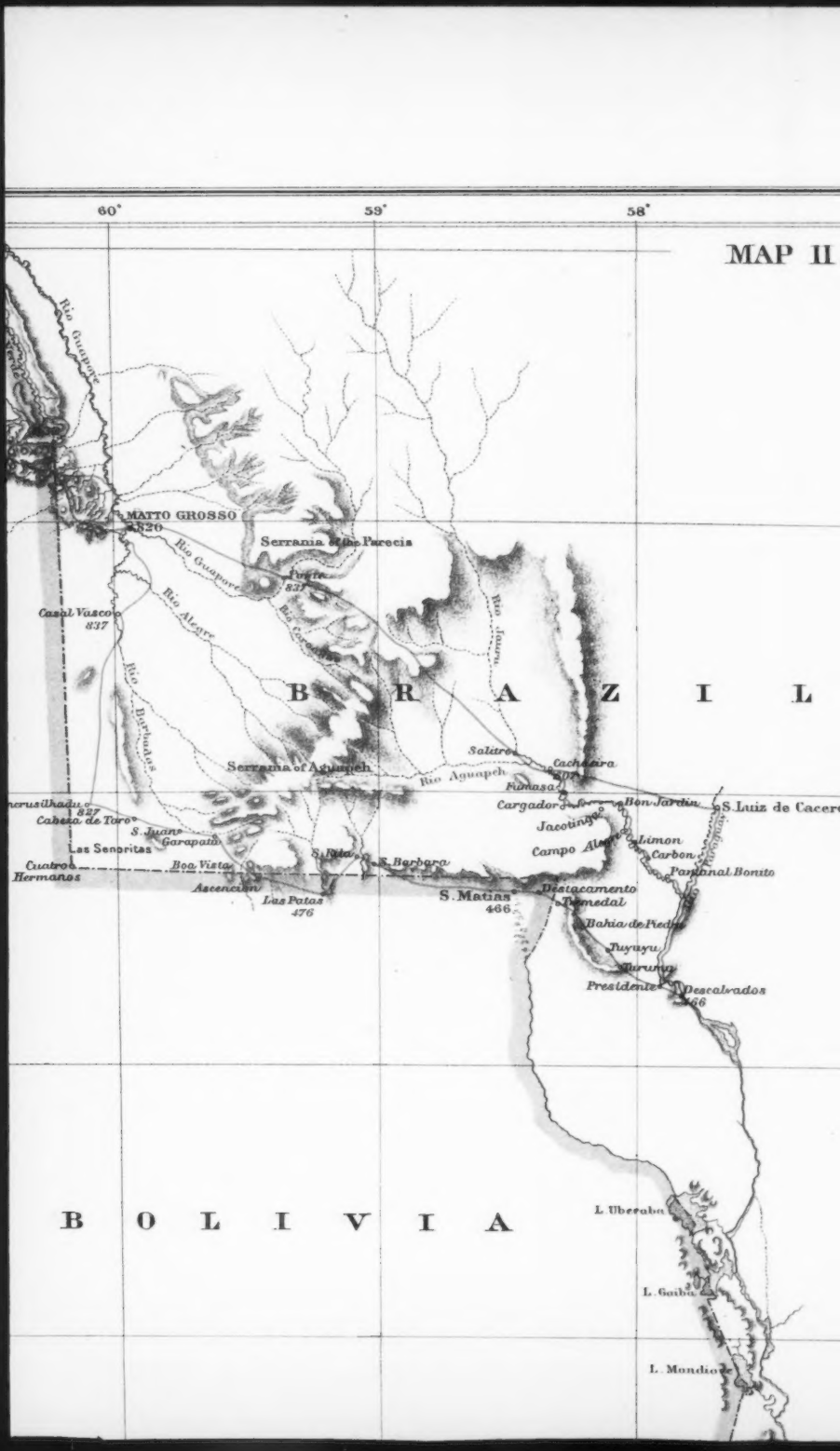
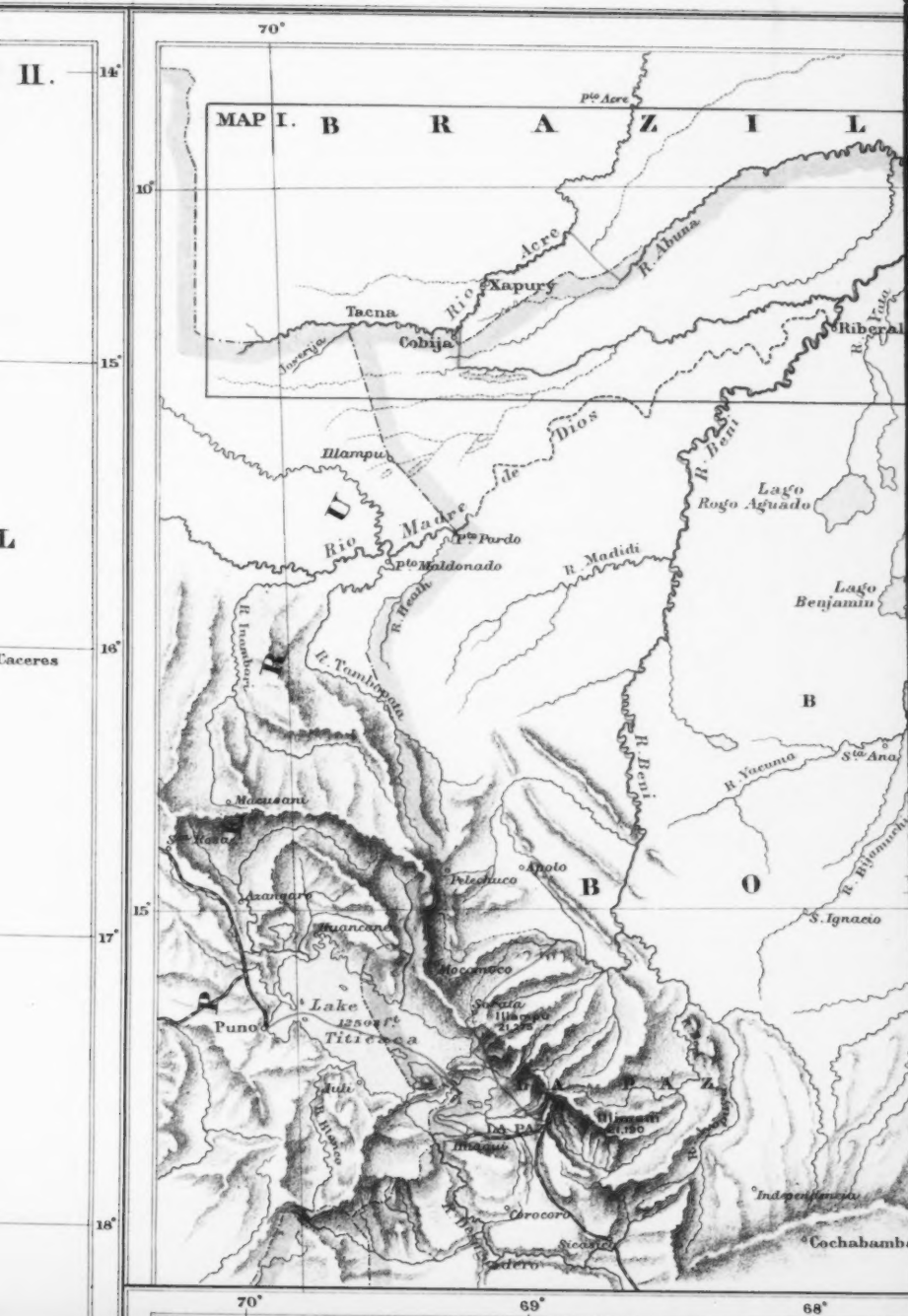
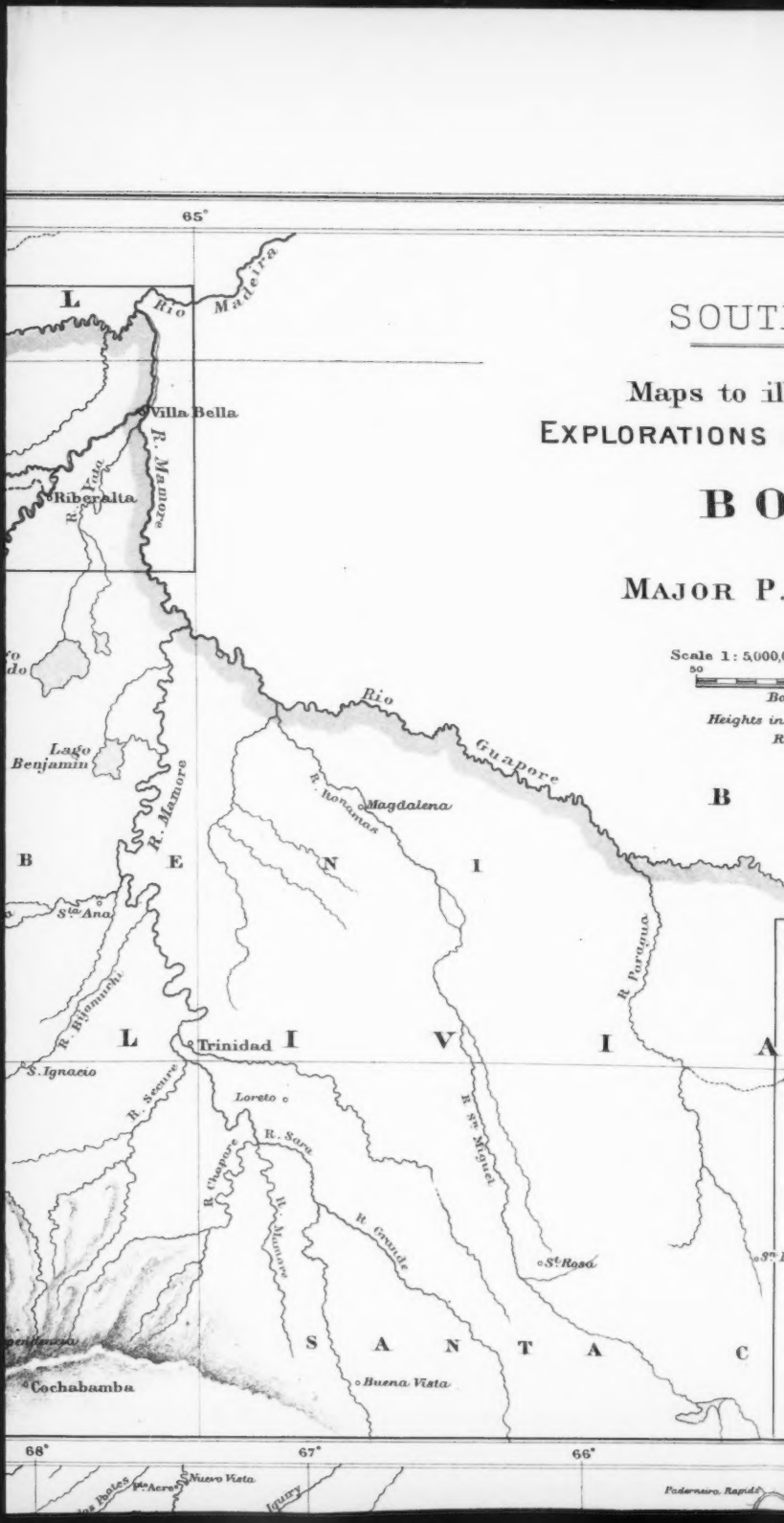
Spioen Berg
4343
Pot Loer
4769
Williston
Slang Berg
4123
Slang Bergen
Draai Kraal
1700
Fraserburg
32
Middel
Roggeveld
Stompies Fontein
800
Sutherland
4723
O N Y
Komsberg Mts
Gans Fontein
1200
Zwaanen Drift
1900
Matjesfontein
Laingsburg
Ladismith
Robertson
Montagu
Lange Berg Range
Swellendam
402
Heidelberg
34
Riversdale
Malagas
Port Beaufort
Bredasdorp
20


14°
15°
16°
17°
18°
Rio Grande
Rio Grande
Casal Va
Encruzilhada
Cabeça de
Las S
Cuatro
Hermanes
B


MAP II
60°
59°
58°
MATTO GROSSO
Serrania of the Parecis
Rio Guapore
Rio Alegre
Rio Jauru
Rio Aguapeh
Serrania of Aguapeh
Rio Barbados
Casal Vasco
837
Cabeza de Toro
S. Juan
Garapata
Las Senoritas
Cuatro Hermanos
Boa Vista
Ascencion
Las Patas
476
S. Rita
S. Barbara
S. Matias
466
Destacamento
Tomedal
Bahia de Pedra
Tuyuyu
Presidente
Descalvados
56
Salitre
Cachoeira
Fumasa
Cargador
Bon Jardin
S. Luiz de Caceres
Jacoutinga
Campo Alegre
Limon
Carbon
Panthanal Bonito
L. Uberaba
L. Gaiba
L. Mandioré
BRAZIL
BOLIVIA


MAP I.
B R A Z I L
70°
69°
68°
10°
15°
16°
17°
18°
Pto Acre
Rio Acre
R. Abuna
Xapury
Tacna
Cobija
Riberal
R. Yata
Iberrija
Illampu
Rio de Dios
R. Beni
Lago Rogo Aguado
Rio Madre
Pto Pardo
Pto Maldonado
R. Madidi
Lago Benjamin
R. Inambari
R. Tambopata
R. Beni
B
R. Yacuma
Sta Ana
Macusani
Sta Rosa
Pelechuco
Apolo
B
O
R. Bijamuchi
Azangaro
Huancane
S. Ignacio
Mocomoco
Lake Titicaca
12500 ft
Puno
Juli
Illimani
21,180
Independencia
Cochabamba
Sicasica
Oruro
Lake Aullagas
12,000 ft


SOUTH
Maps to il
EXPLORATIONS
BO
MAJOR P
Scale 1: 5,000,
50
Heights in
65°
Rio Madeira
Villa Bella
R. Mamore
R. Yata
Riberalta
Lago Benjamin
R. Mamore
Rio Guapore
R. Ronamas
Magdalena
B E N I
B
Sta Ana
R. Blanco
R. Paraguá
L I V I A
Trinidad
S. Ignacio
R. Secure
Loreto
R. Sara
R. Chapore
R. Mamore
R. Grande
R. Sn Miguel
St Rosa
S A N T A C
Cochabamba
Buena Vista
68°
67°
66°
Nuevo Vista
Poderoso Rapids

60°

UTH AMERICA

o illustrate a paper on

IS AND BOUNDARY SURVEYS

IN

OLIVIA

by

P. H. FAWCETT, R.A. [Ret.d]

5,000,000 or 1 Inch = 79 Statute Miles.

0 50 100

Boundaries

hts in feet. Routes

Railways

10°

R A Z I L

MAP II.

A

Matto Grosso
1,320

15°

R. Guaporé

R. Alegre

R. Jauru

R. Barbados

Aguapehy

S. Luiz de Caceres

S.to Ignacio

S. Matias
466

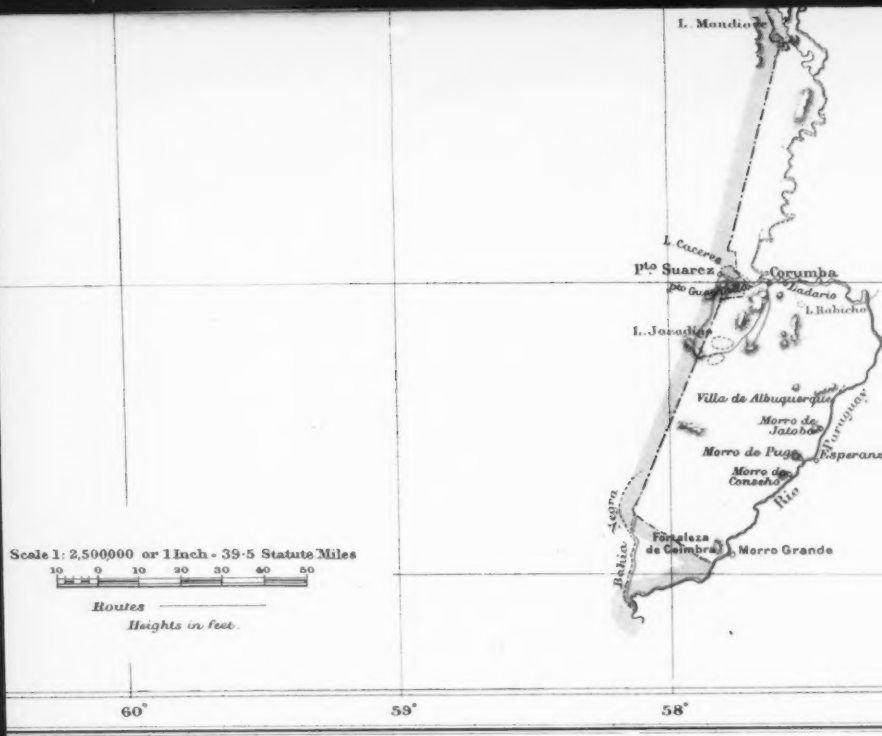
C R U Z

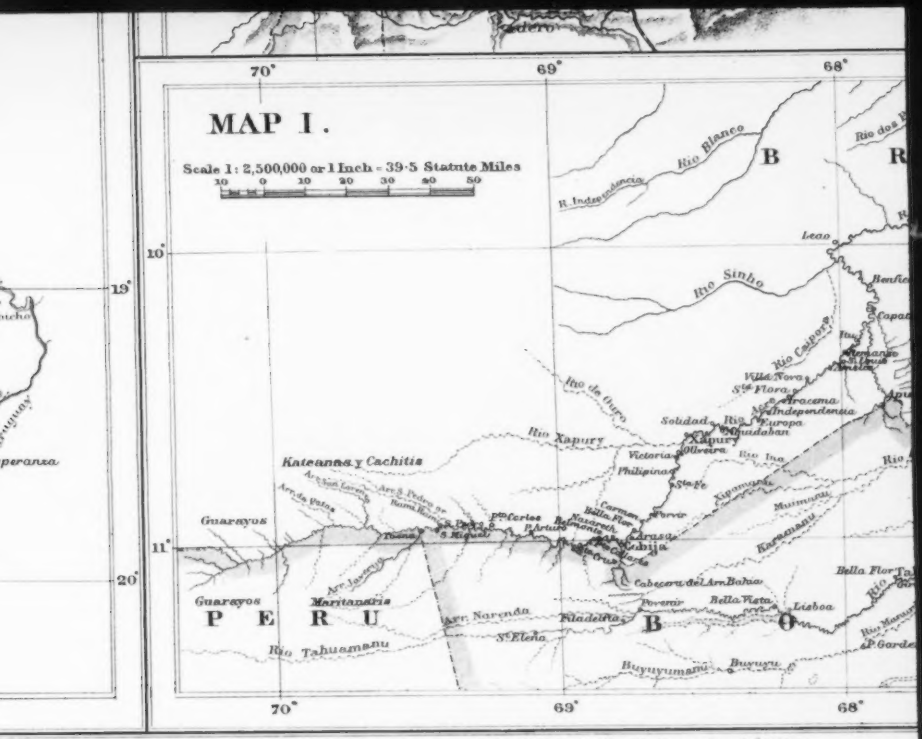
L. Uberaba

L. Gaiba

65°

19°
20°
Scale


I. Mandiore
I. Caceres
pto Suarez
Corumba
pto Guaz
Nadario
I. Rabicha
I. Jacadigo
Villa de Albuquerque
Morro de Jatobá
Morro de Puga
Morro de Conselho
Esperanza
Rio Paraguay
Bahia Negra
Fortaleza de Coimbra
Morro Grande
Scale 1: 2,500000 or 1 Inch = 39·5 Statute Miles
10 0 10 20 30 40 50
Routes
Heights in feet.
60°
59°
58°



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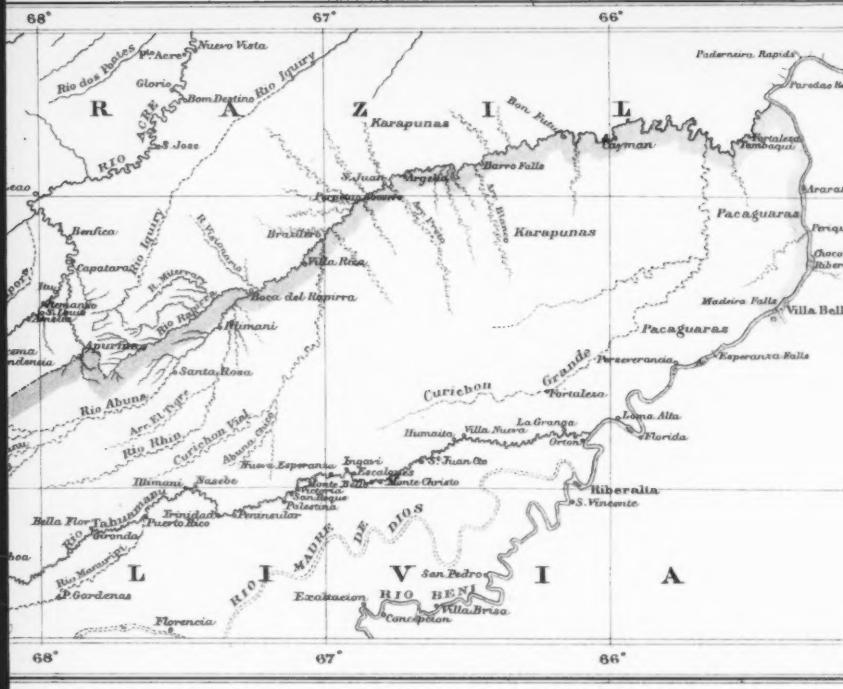
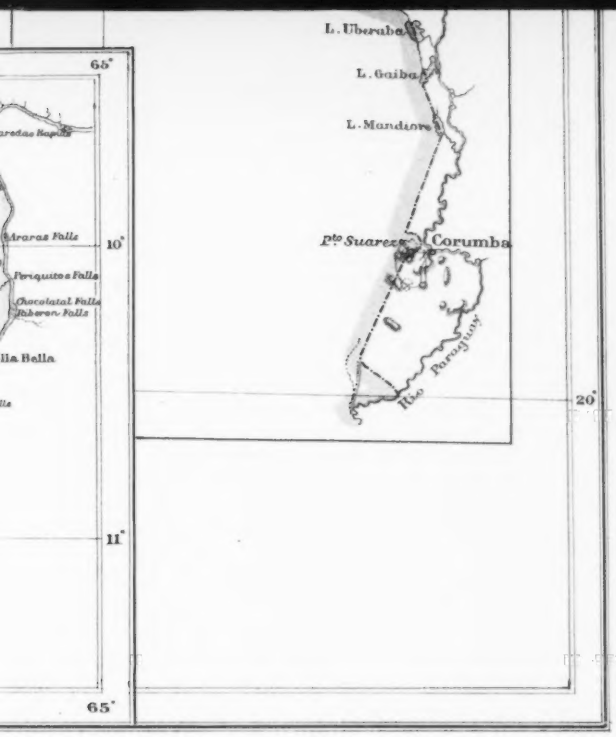
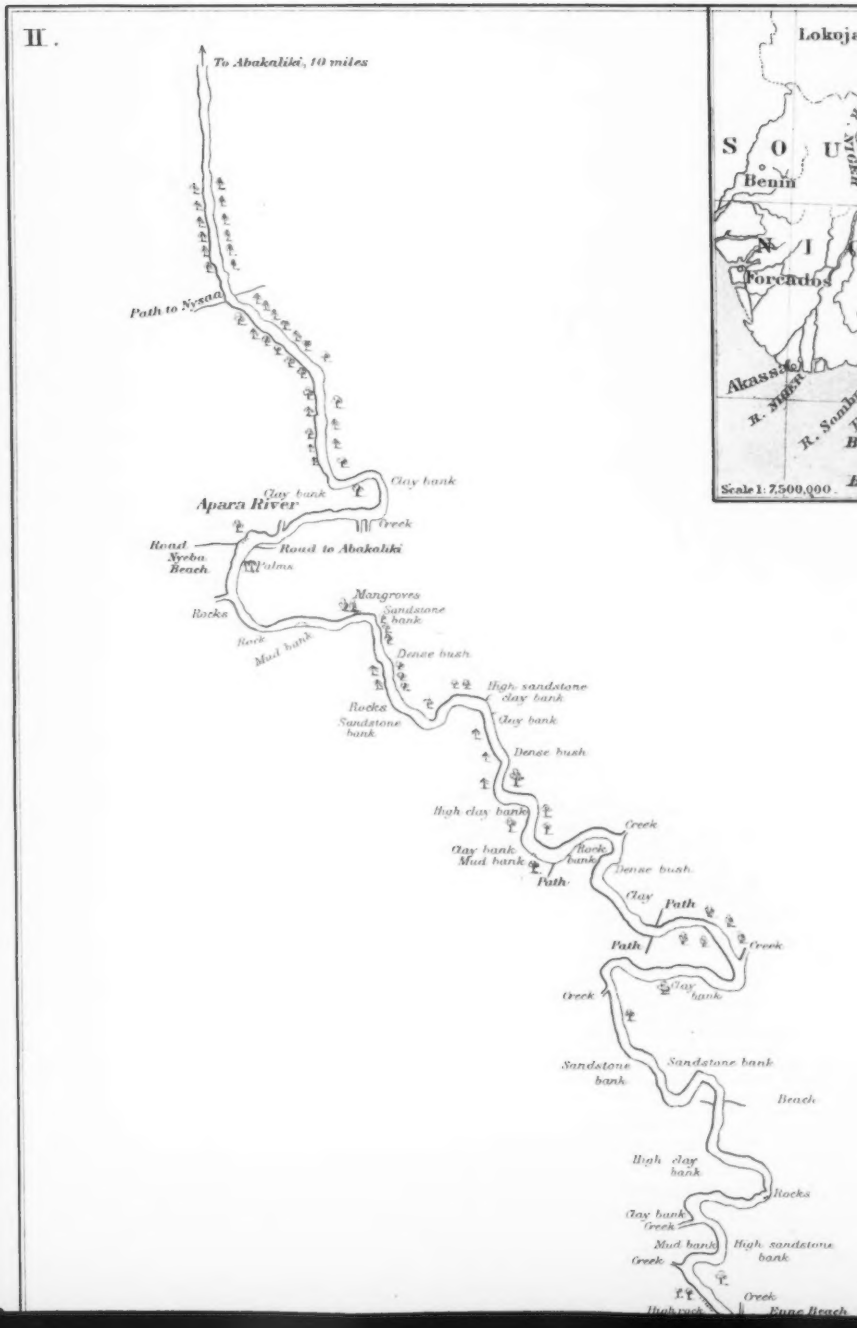
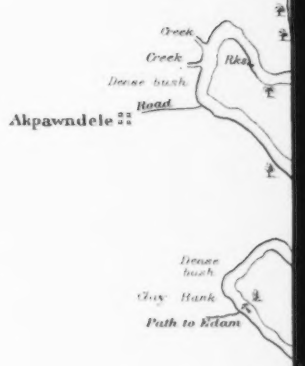

68°
67°
66°
R A Z I L
L I V I A
Nuevo Vista
Gloria
Bom Destino
Rio Iquiry
Rio dos Poetes
Rio Acre
S. Jose
Karapunas
Cayman
Barro Falls
S. Juan
Argelia
Paderneira Rapids
Fortaleza
Tamboqui
Pacaguaras
Benfica
Braxileira
Villa Rica
Capatara
Rio Mizeria
Rio Rapirran
Boca del Ramirra
Rumani
Apurinas
Santa Rosa
Rio Abuna
Arc El Tigre
Rio Rhin
Curichon Viel
Abuna Nuevo
Curichon Grande
Perseverancia
Esperanza Falls
Fortaleza
Loma Alta
La Granja
Florida
Villa Nueva
Ilumaito
Orton
Nueva Esperanza
Engavi
Escaleras
S. Juan Ca
Monte Christo
Monte Bello
Illimani
Nasebe
Riberalta
S. Vincente
Bella Flor
Tahuamanu
Trinidad
Puerto Rico
Palestina
Rio Madre de Dios
San Pedro
Exaltacion
Rio Beni
Villa Brisa
Concepcion
P. Gardenas
Florencia

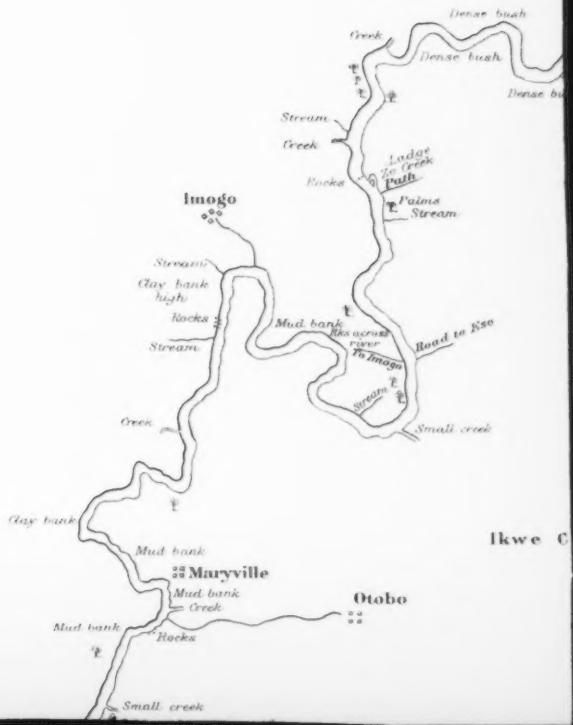

L. Uberuba
L. Gaiba
L. Mandioré
Pto Suarez
Corumba
Rio Paraguay
20°
65°
10°
11°
Araras Falls
Periquitos Falls
Chocolatal Falls
Ribeiron Falls
lia Bella

II.


To Abakaliki, 10 miles
Path to Nysaa
Clay bank
Clay bank
Apara River
Creek
Road to Nyeba Beach
Road to Abakaliki
Palms
Mangroves
Sandstone bank
Rocks
Rock
Mud bank
Dense bush
High sandstone clay bank
Rocks
Sandstone bank
Clay bank
Dense bush
High clay bank
Creek
Clay bank
Mud bank
Rock bank
Dense bush
Path
Clay
Path
Path
Creek
Creek
Clay bank
Sandstone bank
Sandstone bank
Beach
High clay bank
Rocks
Clay bank
Creek
Mud bank
High sandstone bank
Creek
Creek
Lokoja
S O U
Benin
N I
Forcados
Akassa
R. Niger
R. Sanb
Scale 1: 7,500,000

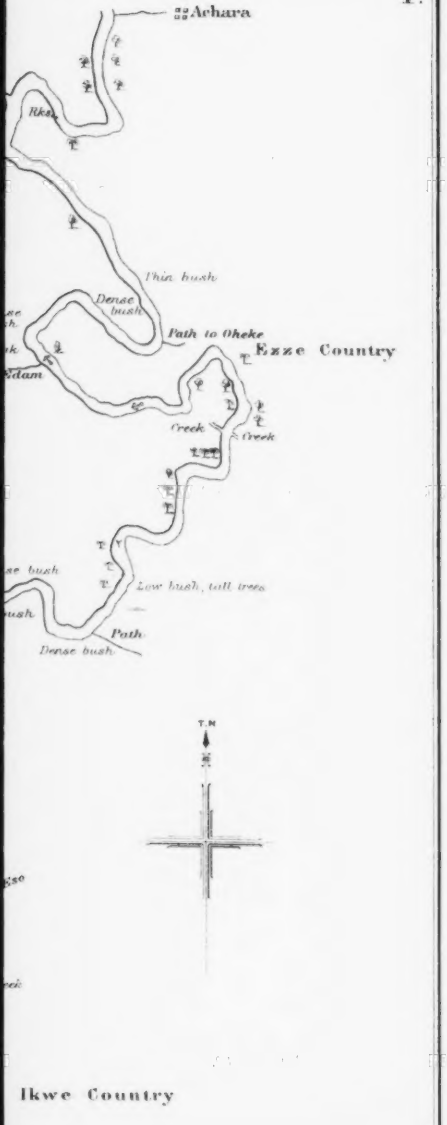
okuja
R. Benue
Wukari
Ida
R. NIGER
U T H E R N
G E R I A
Ossidinge
Cross R.
Calabar
R. Sombreiro
R. Calabar
Bonny R.
R. Opobo
Old Calabar R.
Rio del Rey
Buea
BIGHT OF
Fernando Po
BIAFRA
Cameroon

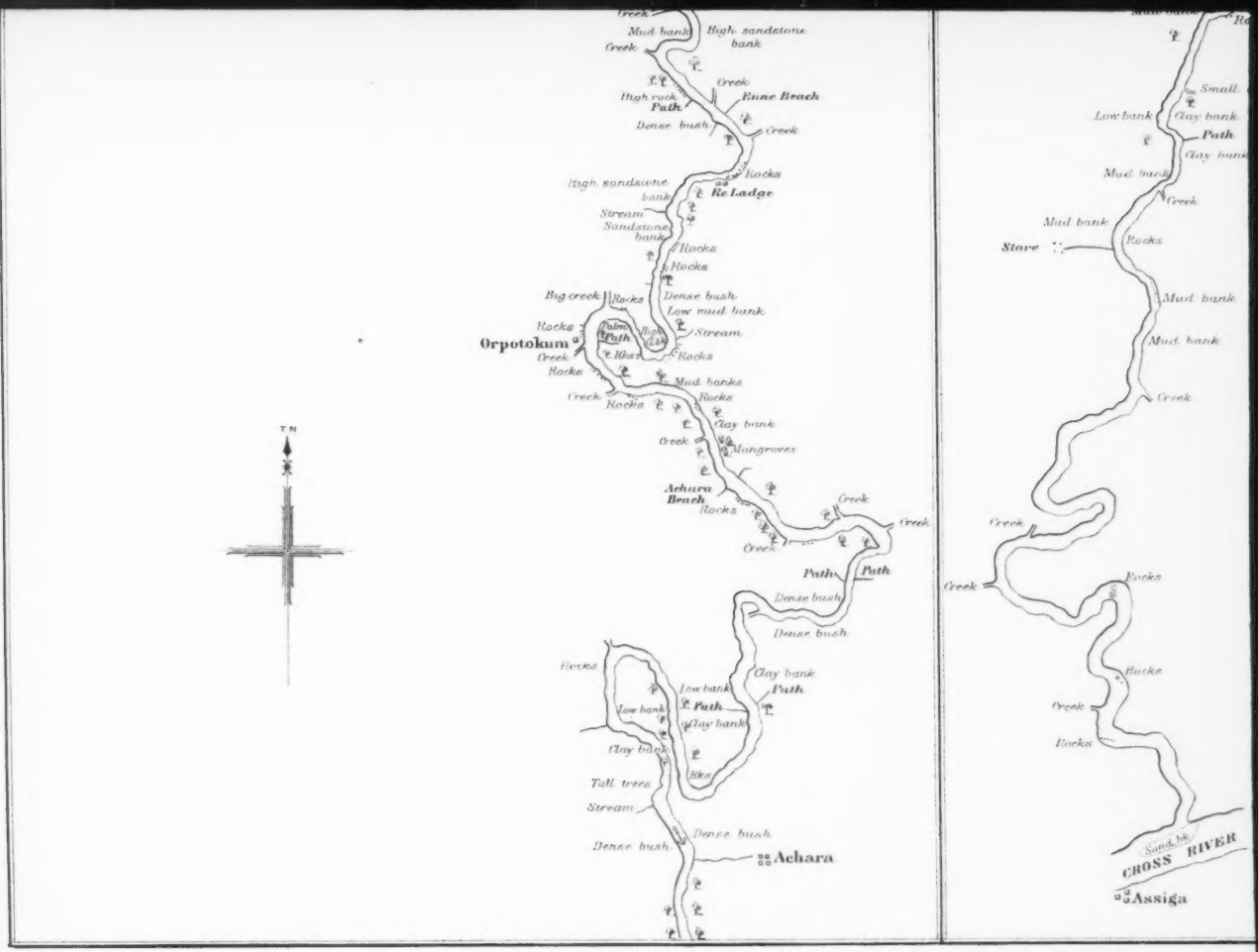

Creek
Creek
Dense bush
Road
Akpawndele
Dense bush
Clay Bank
Path to Edam


Dense bush
Creek
Dense bush
Stream
Creek
Ledge for Creek
Rocks
Path
Palms
Stream
Imogo
Stream
Clay bank high
Rocks
Stream
Mud bank
Rks across river
To Imogo
Road to Eso
Stream
Small creek
Creek
Clay bank
Mud bank
Maryville
Mud bank
Creek
Otobo
Mud bank
Rocks
Small creek
Ikwe C

ABOINIA RIVER.
BURN.

I.





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SOUTHERN NIGERIA

Sketch Map
of the
ABOINIA RIVER,
BY
LIEUT. J. BURN, R.N.R.

Scale 1 : 50,000 or 1 Inch = 0·79 Statute Mile

1 ½ 0 1 Mile

N.B. Average depth of water in dry season 5 Feet.
Rise in rains 20 Feet.